

## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

STEFAN, Lennefors  
Stockholms Patentbyrå Zacco AB  
Box 23101  
S-104 35 Stockholm  
SUÈDE

<b>Date of mailing</b> (day/month/year) 17 April 2001 (17.04.01)	<b>IMPORTANT NOTIFICATION</b>
<b>Applicant's or agent's file reference</b> 103375101	
<b>International application No.</b> PCT/SE00/00024	<b>International filing date</b> (day/month/year) 10 January 2000 (10.01.00)

## 1. The following indications appeared on record concerning:

☐ the applicant
 ☐ the inventor
 ☒ the agent
 ☐ the common representative

## Name and Address

STEFAN, Lennefors  
AB Stockholms Patentbyrå, Zacco &  
Bruhn  
Box 23101  
S-104 35 Stockholm  
Sweden

## State of Nationality

## State of Residence

## Telephone No.

+46 8 729 95 00

## Facsimile No.

+46 8 31 83 15

## Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person
 ☐ the name
 ☒ the address
 ☐ the nationality
 ☐ the residence

## Name and Address

STEFAN, Lennefors  
Stockholms Patentbyrå Zacco AB  
Box 23101  
S-104 35 Stockholm  
Sweden

## State of Nationality

## State of Residence

## Telephone No.

+46 8 729 95 00

## Facsimile No.

+46 8 31 83 15

## Teleprinter No.

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Authorized officer

Jean-Marie McAdams

Facsimile No.: (41-22) 740.14.35

Telephone No.: (41-22) 338.83.38

\_\_\_\_\_

\_\_\_\_\_

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
 US Department of Commerce  
 United States Patent and Trademark  
 Office, PCT  
 2011 South Clark Place Room  
 CP2/5C24  
 Arlington, VA 22202  
 ETATS-UNIS D'AMERIQUE  
 in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 30 October 2000 (30.10.00)	
<b>International application No.</b> PCT/SE00/00024	<b>Applicant's or agent's file reference</b> 103375101
<b>International filing date</b> (day/month/year) 10 January 2000 (10.01.00)	<b>Priority date</b> (day/month/year) 28 January 1999 (28.01.99)
<b>Applicant</b> JOHANSSON, Per-Åke et al	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

31 July 2000 (31.07.00)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Charlotte ENGER Telephone No.: (41-22) 338.83.38
---	---



## PATENT COOPERATION TREATY

PCT

NOTIFICATION CONCERNING  
SUBMISSION OR TRANSMITTAL  
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

From the INTERNATIONAL BUREAU

To:

STEFAN, Lennefors  
AB Stockholms Patentbyrå, Zacco &  
Bruhn  
Box 23101  
S-104 35 Stockholm  
SUÈDE

Date of mailing (day/month/year) 08 March 2000 (08.03.00)	
Applicant's or agent's file reference 103375101	<b>IMPORTANT NOTIFICATION</b>
International application No. PCT/SE00/00024	International filing date (day/month/year) 10 January 2000 (10.01.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 28 January 1999 (28.01.99)
Applicant STFI et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An **asterisk(\*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
28 Janu 1999 (28.01.99)	9900276-8	SE	24 Febr 2000 (24.02.00)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No. (41 22) 719 14 35	Authorized officer S. De Michiel  Telephone No. (41 22) 348 87 32
--	--



## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF RECEIPT OF  
RECORD COPY

(PCT Rule 24.2(a))

To:

STEFAN, Lennefors  
AB Stockholms Patentbyrå, Zacco &  
Bruhn  
Box 23101  
S-104 35 Stockholm  
SUÈDE

Date of mailing (day month year) 08 March 2000 (08.03.00)	<b>IMPORTANT NOTIFICATION</b>
Applicant's or agent's file reference 103375101	International application No. PCT/SE00/00024

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

STFI (for all designated States except US)  
JOHANSSON, Per-Åke et al (for US)

International filing date : 10 January 2000 (10.01.00)  
Priority date(s) claimed : 28 January 1999 (28.01.99)  
Date of receipt of the record copy  
by the International Bureau : 24 February 2000 (24.02.00)  
List of designated Offices :

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE  
National : AU, CA, JP, NZ, US

**ATTENTION**

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- ☒ time limits for entry into the national phase  
☒ confirmation of precautionary designations  
☐ requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41 22) 739 14 35	Authorized officer: S. De Michiel Telephone No. (41 22) 338 83 35
--	---





## INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB 301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is **20 MONTHS** from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, **30 MONTHS** from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. **It is the applicant's responsibility** to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

**For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.**

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

## CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

## REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.



# PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

## PCT

To:

Stockholms Patentbyrå Zacco AB  
Box 23101  
104 35 STOCKHOLM

### NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Applicant's or agent's file reference <b>103375101</b>		Date of mailing <i>(day month year)</i> <b>30-04-2001</b>	
International application No. <b>PCT/SE00/00024</b>		International filing date <i>(day month year)</i> <b>10-01-2000</b>	
Priority date <i>(day month year)</i> <b>28-01-1999</b>		<b>IMPORTANT NOTIFICATION</b>	
Applicant <b>STFI</b> <b>et al</b>			

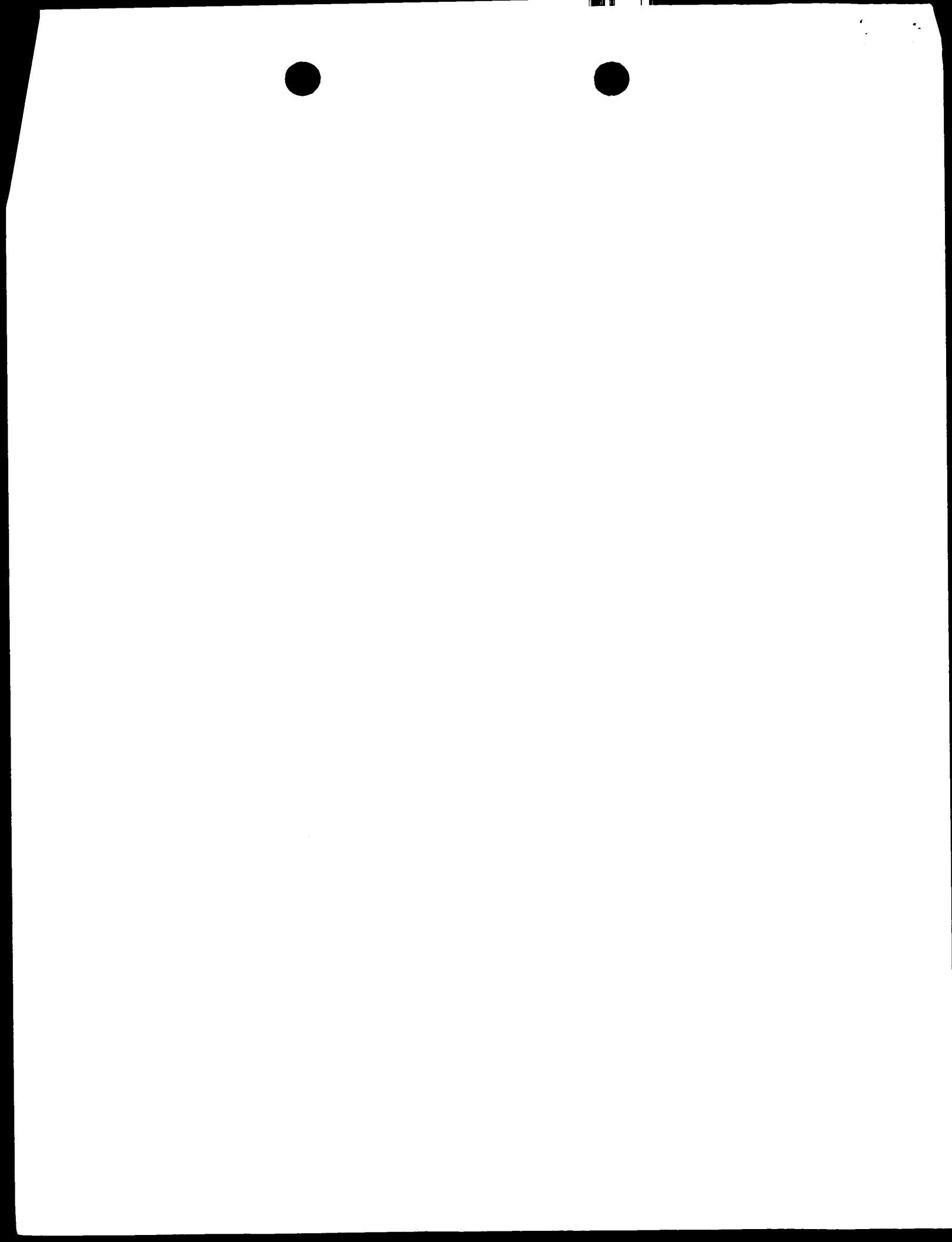
1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT-IB 301).

where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No.      08-667 72 88	Authorized officer  Telephone No.      08 782 25 00
--	---



## TENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

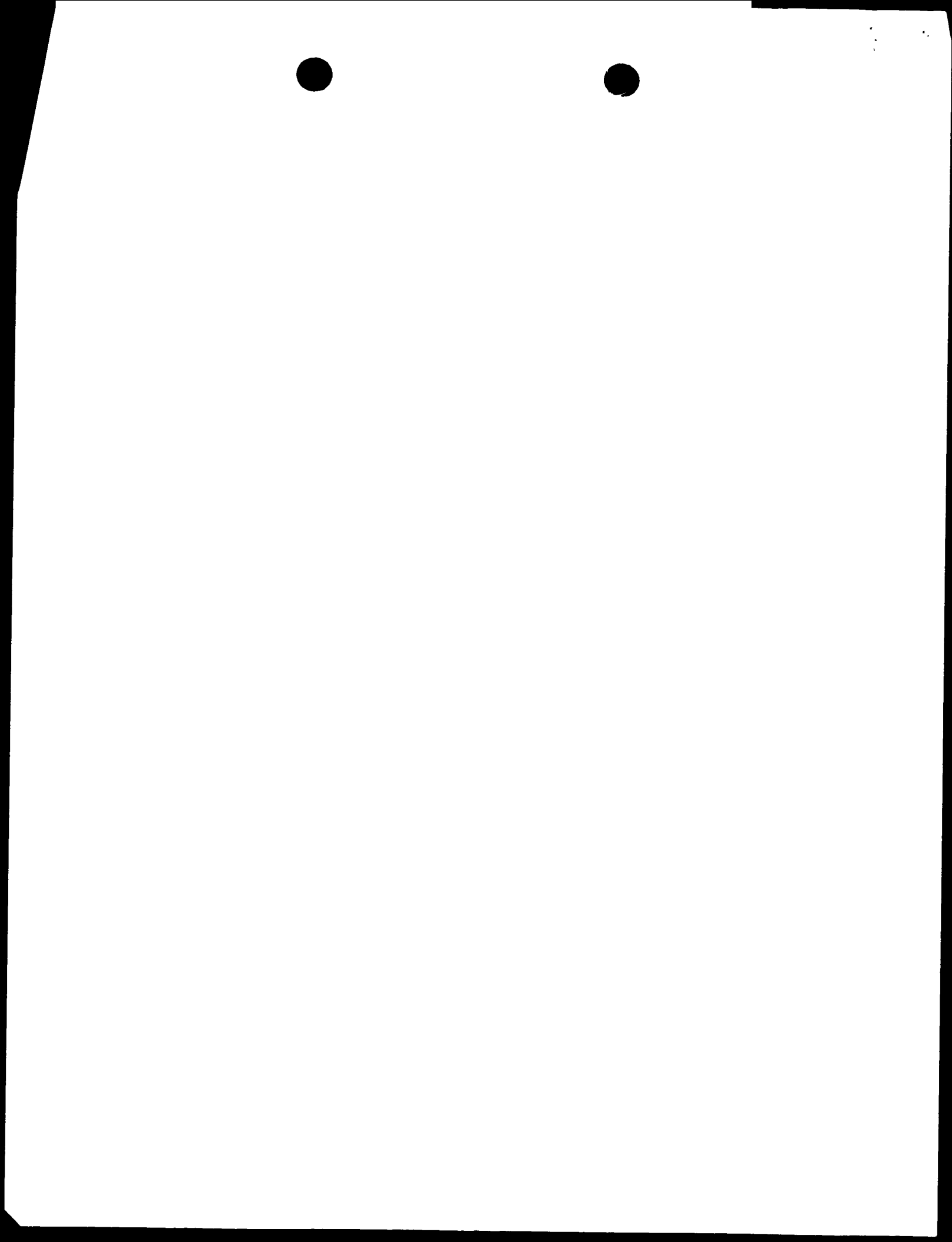
Applicant's or agent's file reference 103375101	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE00/00024	International filing date ( <i>day month year</i> ) 10-01-2000	Priority date ( <i>day month year</i> ) 28-01-1999
International Patent Classification (IPC) or national classification and IPC7 G01B 11/24, G01B 11/30		
Applicant STFI et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
- ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of \_\_\_\_\_ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 31-07-2000	Date of completion of this report 23-04-2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5085 S-102 42 STOCKHOLM Facsimile No. 03-667 72 88	Authorized officer Jerry Vennerholm /itw Telephone No. 08-782 25 00



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/00024

## I. Basis of the report

1. With regard to the **elements** of the international application:\*

- ☒ the international application as originally filed
- ☐ the description:  
 pages \_\_\_\_\_, as originally filed  
 pages \_\_\_\_\_, filed with the demand  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the claims:  
 pages \_\_\_\_\_, as originally filed  
 pages \_\_\_\_\_, as amended (together with any statement) under article 19  
 pages \_\_\_\_\_, filed with the demand  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the drawings:  
 pages \_\_\_\_\_, as originally filed  
 pages \_\_\_\_\_, filed with the demand  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
 pages \_\_\_\_\_, as originally filed  
 pages \_\_\_\_\_, filed with the demand  
 pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language ENGLISH which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.





# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/00024

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Claims	<u>1-13</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-13</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-13</u>	YES
	Claims		NO

### 2. Citations and explanations (Rule 70.7)

The claimed invention relates to an image analysis method for determining a surface topography. The method involves recording the intensity of diffuse light reflected by the same surface area from two different illumination angles. The difference between the recorded intensities is determined to obtain a representation that emphasises variations in gradient of the surface.

### Documents cited in the International Search Report:

D1 US, A, 5835190  
D2 EP, A2, 0764845  
D3 US, A, 4162126  
D4 WO, A1, 9836240  
D5 JP, A, 61082106  
D6 JP, A, 61198009  
D7 JP, A, 60135704

Document D1 relates to an ophthalmologic curvature measuring device and method. The device uses an optical projection system to first project a pair of light beams to cornea on to a central area of the surface to be measured and notes the direction of reflection from these. A second pair of light beams is then projected on to a second area of the cornea, outside the first area but on the same axis. An objective lens transmits both first and second reflected beams to a measuring system where the angle difference is detected, from which a microprocessor calculates the curvature. The system requires no movement of the patient's eye but accurately measures the curvature of the central and circumference area of the cornea.

... / ...



**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

Document D2 relates to an apparatus for detecting defective portions on a smooth surface. The surface is scanned by an imager for shadows by high spots or recesses under illumination by red and green light from projectors inclined at different angles to the direction of movement of the board. The imager is equipped with a colour camera which records the mixture of colours reflected from the surface under inspection. The signal components of the different colours may be subtracted or their ratio may be determined.

Document D3 relates to a surface defect test apparatus and method. The system for testing surface defect on an object comprises an illumination device for illuminating collimated lights onto a surface of the object obliquely to the surface and from two symmetrical directions. A sensor composed of a TV camera or a linear image sensor detects diffused reflected lights from the surface of the object in the direction perpendicular to the surface. A classification device discriminates the sensed image signal by a threshold level, which is higher than an average level of the image signal and a threshold level, which is lower than the average level to determine the surface defect pattern as a broken cavity pattern or a pit or crack pattern by the discriminated signals.

Document D4 relates to a method and a device for measuring and quantifying surface defects on a test surface with a light source. The method records two partial images with a camera during the illumination of the test surface with parallel light or spot lighting. The angle of incidence in relation to the test surface and the location of the camera is different when recording different partial images. The recorded partial images are processed in a central unit and one or several difference images are produced from the partial images. The difference images are used to determine the degree of surface defect on the test surface. The light source is placed in different positions to record the different images.

Documents D5-D7 define the general state of the art, and are considered not to be of particular relevance.

None of the documents shows, according to the invention, an image analysis method for determining a surface topography method characterised by: recording the intensity of diffusely reflected light from the surface in a first and a second image, taken from two different illumination angles; ... / ...



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/00024

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

determining the difference between the recorded intensities of the first and the second image in order to obtain a representation that emphasises variations in gradient of the surface.

It is neither obvious for a person skilled in the art to obtain the invention, as defined in the independent claim 1, from the combined subject matters of the cited documents.

Accordingly, claims 1-13 do fulfil the requirements of novelty (N), inventive step (IS) and industrial applicability (IA).



## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>103375101</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT ISA 220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/SE 00/00024</b>	International filing date ( <i>day month year</i> ) <b>10 January 2000</b>	(Earliest) Priority Date ( <i>day month year</i> ) <b>28 January 1999</b>
Applicant <b>STFI et al</b>		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. ☐ Certain claims were found unsearchable (See Box I).
2. ☐ Unity of invention is lacking (See Box II).
3. ☐ The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
  - ☐ filed with the international application.
  - ☐ furnished by the applicant separately from the international application,
    - ☐ but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
  - ☐ transcribed by this Authority.
4. With regard to the title, ☒ the text is approved as submitted by the applicant.  
☐ the text has been established by this Authority to read as follows:
5. With regard to the abstract,
  - ☒ the text is approved as submitted by the applicant.
  - ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the drawings to be published with the abstract is:  
 Figure No. 2 ☒ as suggested by the applicant. ☐ None of the figures.  
☐ because the applicant failed to suggest a figure.  
☐ because this figure better characterizes the invention.





## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00024

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01B 11/29, G01B 11/30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5835190 A (NOBUYUKI MIYAKE), 10 November 1998 (10.11.98) --	1-13
A	EP 0764845 A2 (AUTRONIC GESELLSCHAFT FÜR BILDVERARBEITUNG UND SYSTEME MBH), 26 March 1997 (26.03.97) --	1-13
A	US 4162126 A (YASUO NAKAGAWA ET AL), 24 July 1979 (24.07.79) --	1-13
A	WO 9836240 A1 (AB VOLVO), 20 August 1998 (20.08.98) --	1-13

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 May 2000	
Name and mailing address of the ISA Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer  Jerry Vennerholm/mj Telephone No. +46 8 782 25 00



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP 00/00024

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 61082106 (TOKYO DORO ENJINA KK) 1986-04-25 (abstract).(online)(retrived on 2000-05-19). Retrived from:EPO PAJ Database  --	1-13
A	JP 61198009 (SONY CORP) 1986-09-02 (abstract).(online)(retrived on 2000-05-19) Retrived from: EPO PAJ Database  --	1-13
A	JP 60135704 (HITACHI SEISAKUSHO KK) 1985-07-19 (abstract).(online)(retrived on 2000-05-19). Retrived from EPO PAJ Database  -- -----	1-13



**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

02/12/99

International application No.  
PCT/SE 00/00024

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	5835190	A	10/11/98	DE	19715212 A	30/10/97
				JP	9276223 A	28/10/97
-----						
EP	0764845	A2	26/03/97	DE	19534716 A,C	20/03/97
-----						
US	4162126	A	24/07/79	JP	53072679 A	28/06/78
				JP	1388448 C	14/07/87
				JP	53079571 A	14/07/78
				JP	61047362 B	18/10/86
-----						
WO	9836240	A1	20/08/98	AU	6233498 A	08/09/98
				EP	0890008 A	13/01/99
				NO	984427 A	23/09/98
				SE	508822 C	09/11/98
				SE	9700539 A	18/08/98
-----						



REVISED VERSION

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
3 August 2000 (03.08.2000)

PCT

(10) International Publication Number  
**WO 00/45125 A1**

(51) International Patent Classification<sup>7</sup>: **G01B 11/24**,  
11/30

**Per-Åke** [SE/SE]; Dalagatan 20, S-113 24 Stockholm  
(SE). **HANSSON, Peter** [SE/SE]; Genberg, Gårdsfogde-  
vägen 29, S-161 70 Bromma (SE).

(21) International Application Number: PCT/SE00/00024

(22) International Filing Date: 10 January 2000 (10.01.2000)

(74) Agents: **STEFAN, Lennefors** et al.: AB Stockholms  
Patentbyrå, Zacco & Bruhn, Box 23101, S-104 35 Stock-  
holm (SE).

(25) Filing Language: Swedish

(81) Designated States (*national*): AU, CA, JP, NZ, US.

(26) Publication Language: English

(84) Designated States (*regional*): European patent (AT, BE,  
CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,  
NL, PT, SE).

(30) Priority Data:  
9900276-8 28 January 1999 (28.01.1999) SE

(71) Applicant (*for all designated States except US*): **STFI**  
[SE/SE]; Box 5604, S-114 86 Stockholm (SE).

Published:  
— With international search report.

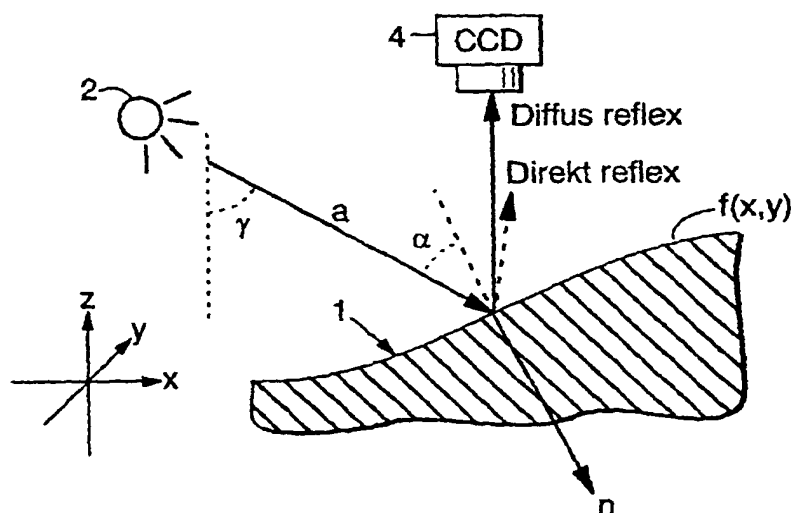
(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **JOHANSSON,**

(88) Date of publication of the revised international search  
report: 7 December 2000

[Continued on next page]

(54) Title: METHOD OF DETERMINING AN ILLUMINATED SURFACE



(57) Abstract: Method of determining a surface illuminated by incident light. First the intensity ( $I_1(x,y)$ ) of light reflected from the surface is recorded in a first image of the surface. After this, the intensity ( $I_2(x,y)$ ) of light reflected from the surface is recorded in a second image of the surface, taken at a different angle of illumination. Only the diffusely reflected light is recorded. The difference between the recorded intensities of the first and the second images is determined to obtain a representation that emphasises variations in gradient of the surface. This representation is further processed by signal-adapted integration to a topographic description, that is, a height function of the surface.

WO 00/45125 A1





## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00024

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01B 11/24, G01B 11/30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5835190 A (NOBUYUKI MIYAKE), 10 November 1998 (10.11.98) --	1-13
A	EP 0764845 A2 (AUTRONIC GESELLSCHAFT FÜR BILDVERARBEITUNG UND SYSTEME MBH), 26 March 1997 (26.03.97) --	1-13
A	US 4162126 A (YASUO NAKAGAWA ET AL), 24 July 1979 (24.07.79) --	1-13
A	WO 9836240 A1 (AB VOLVO), 20 August 1998 (20.08.98) --	1-13

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

4 August 2000

Date of mailing of the international search report

08-08-2000

Name and mailing address of the ISA

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Jerry Vennerholm/mj

Telephone No. +46 8 782 25 00



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00024

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 61082106 (TOKYO DORO ENJINA KK) 1986-04-25 (abstract).(online)(retrived on 2000-05-19). Retrived from:EPO PAJ Database  --	1-13
A	JP 61198009 (SONY CORP) 1986-09-02 (abstract).(online)(retrived on 2000-05-19) Retrived from: EPO PAJ Database  --	1-13
A	JP 60135704 (HITACHI SEISAKUSHO KK) 1985-07-19 (abstract).(online)(retrived on 2000-05-19). Retrived from EPO PAJ Database  -- -----	1-13



**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

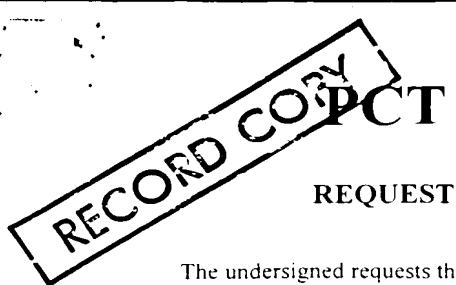
02/12/99

International application No.

PCT/SE 00/00024

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	5835190	A	10/11/98	DE	19715212 A	30/10/97
				JP	9276223 A	28/10/97
-----						
EP	0764845	A2	26/03/97	DE	19534716 A,C	20/03/97
-----						
US	4162126	A	24/07/79	JP	53072679 A	28/06/78
				JP	1388448 C	14/07/87
				JP	53079571 A	14/07/78
				JP	61047362 B	18/10/86
-----						
WO	9836240	A1	20/08/98	AU	6233498 A	08/09/98
				EP	0890008 A	13/01/99
				NO	984427 A	23/09/98
				SE	508822 C	09/11/98
				SE	9700539 A	18/08/98
-----						





## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

PCT/RO/01/00024

International Filing Date

10-01-2000

Name of receiving Office and "PCT International Application"

The Swedish Patent Office  
PCT International ApplicationApplicant's or agent's file reference  
(if desired) (12 characters maximum)

103375101

**Box No. I TITLE OF INVENTION****Method of determining an illuminated surface****Box No. II APPLICANT**

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no state of residence is indicated below.)

STFI  
Box 5604  
SE-114 86 STOCKHOLM  
Sweden

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State (that is, country) of nationality:

Sweden

State (that is, country) of residence:

Sweden

This person is applicant  
for the purposes of:☐all designated  
States☒all designated States except  
the United States of America☐the United States  
of America only☐the States indicated in  
the Supplemental Box**Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)**

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no state of residence is indicated below.)

JOHANSSON, Per-Åke  
Dalagatan 20  
SE-113 24 STOCKHOLM  
Sweden

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (If this check-box  
is marked, do not fill in below.)

State (that is, country) of nationality:

Sweden

State (that is, country) of residence:

Sweden

This person is applicant  
for the purposes of:☐all designated  
States☐all designated States except  
the United States of America☒the United States  
of America only☐the States indicated in  
the Supplemental Box☒ Further applicants and/or (further) inventors are indicated on a continuation sheet**Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE**

The person identified below is/has been appointed to act on behalf  
of the applicant(s) before the competent International Authorities as:

☒

agent

☐

common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

Stefan Lennefors  
AB STOCKHOLMS PATENTBYRÅ, Zacco & Bruhn  
Box 23101, SE-104 35 STOCKHOLM, Sweden

Telephone No.

+46 8 729 95 00

Facsimile No.

+46 8 31 83 15

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

21





## Continuation of Box No. III

## FURTHER APPLICANTS AND/OR (FURTHER) INVENTORS

*If none of the following sub-boxes is used, this sheet is not to be included in the request.*

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.)

HANSSON, Peter  
c/o Genberg  
Gårdsfogdevägen 29  
SE-161 70 BROMMA  
Sweden

This person is:

- ☐ applicant only  
☒ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

Sweden

State (i.e. country) of residence:

Sweden

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.)

This person is:

- ☐ applicant only  
☐ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.)

This person is:

- ☐ applicant only  
☐ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no state of residence is indicated below.)

This person is:

- ☐ applicant only  
☐ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.



10.01.2000

## Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

## Regional Patent

- ☐ **AP ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SI Sierra Leone, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☐ **EA Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☐ **OA OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)


## National Patent (if other kind of protection or treatment desired, specify on dotted line):

- |   |   |
|---|---|
| <input type="checkbox"/> AE United Arab Emirates                  | <input type="checkbox"/> LR Liberia                                   |
| <input type="checkbox"/> AL Albania                               | <input type="checkbox"/> LS Lesotho                                   |
| <input type="checkbox"/> AM Armenia                               | <input type="checkbox"/> LT Lithuania                                 |
| <input type="checkbox"/> AT Austria                               | <input type="checkbox"/> LU Luxembourg                                |
| <input checked="" type="checkbox"/> AU Australia                  | <input type="checkbox"/> LV Latvia                                    |
| <input type="checkbox"/> AZ Azerbaijan                            | <input type="checkbox"/> MD Republic of Moldova                       |
| <input type="checkbox"/> BA Bosnia and Herzegovina                | <input type="checkbox"/> MG Madagascar                                |
| <input type="checkbox"/> BB Barbados                              | <input type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input type="checkbox"/> BG Bulgaria                              | <input type="checkbox"/> MN Mongolia                                  |
| <input type="checkbox"/> BR Brazil                                | <input type="checkbox"/> MW Malawi                                    |
| <input type="checkbox"/> BY Belarus                               | <input type="checkbox"/> MX Mexico                                    |
| <input checked="" type="checkbox"/> CA Canada                     | <input type="checkbox"/> NO Norway                                    |
| <input type="checkbox"/> CH and LI Switzerland and Liechtenstein  | <input checked="" type="checkbox"/> NZ New Zealand                    |
| <input type="checkbox"/> CN China                                 | <input type="checkbox"/> PL Poland                                    |
| <input type="checkbox"/> CR Costa Rica                            | <input type="checkbox"/> PT Portugal                                  |
| <input type="checkbox"/> CU Cuba                                  | <input type="checkbox"/> RO Romania                                   |
| <input type="checkbox"/> CZ Czech Republic                        | <input type="checkbox"/> RU Russian Federation                        |
| <input type="checkbox"/> DE Germany                               | <input type="checkbox"/> SD Sudan                                     |
| <input type="checkbox"/> DK Denmark                               | <input type="checkbox"/> SE Sweden                                    |
| <input type="checkbox"/> DM Dominica                              | <input type="checkbox"/> SG Singapore                                 |
| <input type="checkbox"/> EE Estonia                               | <input type="checkbox"/> SI Slovenia                                  |
| <input type="checkbox"/> ES Spain                                 | <input type="checkbox"/> SK Slovakia                                  |
| <input type="checkbox"/> FI Finland                               | <input type="checkbox"/> SL Sierra Leone                              |
| <input type="checkbox"/> GB United Kingdom                        | <input type="checkbox"/> TJ Tajikistan                                |
| <input type="checkbox"/> GD Grenada                               | <input type="checkbox"/> TM Turkmenistan                              |
| <input type="checkbox"/> GE Georgia                               | <input type="checkbox"/> TR Turkey                                    |
| <input type="checkbox"/> GH Ghana                                 | <input type="checkbox"/> TT Trinidad and Tobago                       |
| <input type="checkbox"/> GM Gambia                                | <input type="checkbox"/> TZ Tanzania                                  |
| <input type="checkbox"/> HR Croatia                               | <input type="checkbox"/> UA Ukraine                                   |
| <input type="checkbox"/> HU Hungary                               | <input type="checkbox"/> UG Uganda                                    |
| <input type="checkbox"/> ID Indonesia                             | <input checked="" type="checkbox"/> US United States of America       |
| <input type="checkbox"/> IL Israel                                | <input type="checkbox"/> UZ Uzbekistan                                |
| <input type="checkbox"/> IN India                                 | <input type="checkbox"/> VN Viet Nam                                  |
| <input type="checkbox"/> IS Iceland                               | <input type="checkbox"/> YU Yugoslavia                                |
| <input checked="" type="checkbox"/> JP Japan                      | <input type="checkbox"/> ZA South Africa                              |
| <input type="checkbox"/> KE Kenya                                 | <input type="checkbox"/> ZW Zimbabwe                                  |
| <input type="checkbox"/> KG Kyrgyzstan                            |   |
| <input type="checkbox"/> KP Democratic People's Republic of Korea |   |
| <input type="checkbox"/> KR Republic of Korea                     |   |
| <input type="checkbox"/> KZ Kazakhstan                            |   |
| <input type="checkbox"/> LC Saint Lucia                           |   |
| <input type="checkbox"/> LK Sri Lanka                             |   |

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

**Precautionary Designation Statement:** In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)



<b>Box No. VI PRIORITY CLAIM</b>		<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.		
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application: * regional Office	international application receiving Office
item (1) 28/1/99 28 January 1999	9900276-8	SE		
item (2)				
item (3)				
<input checked="" type="checkbox"/> The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): <u>(1)</u>				
<p>* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.</p>				
<b>Box No. VII INTERNATIONAL SEARCHING AUTHORITY</b>				
<b>Choice of International Searching Authority (ISA)</b> (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):		<b>Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):</b>		
ISA / SE		Date (day/month/year)	Number	Country (or regional Office)
<b>Box No. VIII CHECK LIST; LANGUAGE OF FILING</b>				
This international application contains the following number of sheets:		This international application is accompanied by the item(s) marked below:		
request	: 5 ✓	1. <input checked="" type="checkbox"/> fee calculation sheet		
description (excluding sequence listing part)	: 7 ✓	2. <input type="checkbox"/> separate signed power of attorney		
claims	: 2 ✓	3. <input type="checkbox"/> copy of general power of attorney; reference number, if any:		
abstract	: 1 ✓	4. <input type="checkbox"/> statement explaining lack of signature		
drawings	: 5 ✓	5. <input type="checkbox"/> priority document(s) identified in Box No VI as item(s):		
sequence listing part of description	:	6. <input type="checkbox"/> translation of international application into (language):		
Total number of sheets:	20 ✓	7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material		
		8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form		
		9. <input checked="" type="checkbox"/> other (specify): List of representatives		
Figure of the drawings which should accompany the abstract: Fig. 2		Language of filing of the international application: Swedish		
<b>Box No. IX SIGNATURE OF APPLICANT OR AGENT</b>				
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).				
Stockholm, 10 January 2000   Stefan Lennéfors Representative of the applicant				

For receiving Office use only		2. Drawings:	
1. Date of actual receipt of the purported international application:	10 -01- 2000	<input checked="" type="checkbox"/> received:	
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		<input type="checkbox"/> not received:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):			
5. International Searching Authority (if two or more are competent):	ISA / SE	<input type="checkbox"/> 6. Transmittal of search copy delayed until search fee is paid	

For International Bureau use only	
Date of receipt of the record copy by the International Bureau:	24 FEBRUARY 2000 ( 24. 02. 00 )



**Supplemental box***If the Supplemental Box is not used, this sheet should not be included in the request.*

1. *If, in any of the Boxes, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ..." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:*
  - (i) *If more than two persons are involved as applicants and/or inventors and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is country) of residence if no State of residence is indicated below:*
  - (ii) *If, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant:*
  - (iii) *If, in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor:*
  - (iv) *If, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*
  - (v) *If, in Box No. V, the name of any State (or OAPI) is accompanied by the indication "patent addition" or "certificate of addition" or if, in Box No. V, the name of the United States of America is accompanied by an indication "continuation" or "continuation-in-part": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application:*
  - (vi) *If, in Box No. VI, there are more than three earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicated for each additional earlier application the same type of information as required in Box No. VI:*
  - (vii) *If, in Box No. VI, the earlier application is an ARIPO application: in such case, write "Continuation of Box No. VI", specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed.*
2. *If, with regard to the precautionary designation statement contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.*
3. *If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning non-prejudicial disclosures of exceptions to lack of novelty: in such case, write "Statement concerning non-prejudicial disclosures or exceptions to lack of novelty" and furnish that statement below.*

**CONTINUATION OF BOX IV:****Further representatives:**

Agvald-Glas, Gunilla  
 Bernhult, Lennart  
 Bjerndell, Per  
 Brundin; Gabriella  
 Grahm, Cecilia  
 Granström, Lars-Eric  
 Grip, Joakim  
 Hansson, Hans-Erik  
 Hansson, Sven A.  
 Hinz, Udo  
 Karlsson, Per Tomas  
 Lennefors, Stefan  
 Lundström, Maria  
 Nilsson, Brita  
 Nordén, J. Åke  
 Onn, Thorsten  
 Petré, Urban  
 Rilton, Kristina  
 Westerlund, Örjan  
 Åström, Elsa





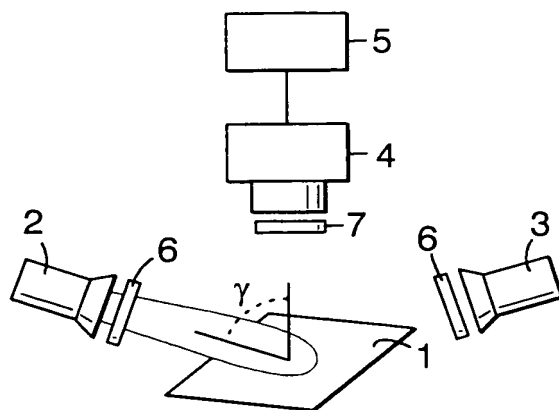


FIG. 1

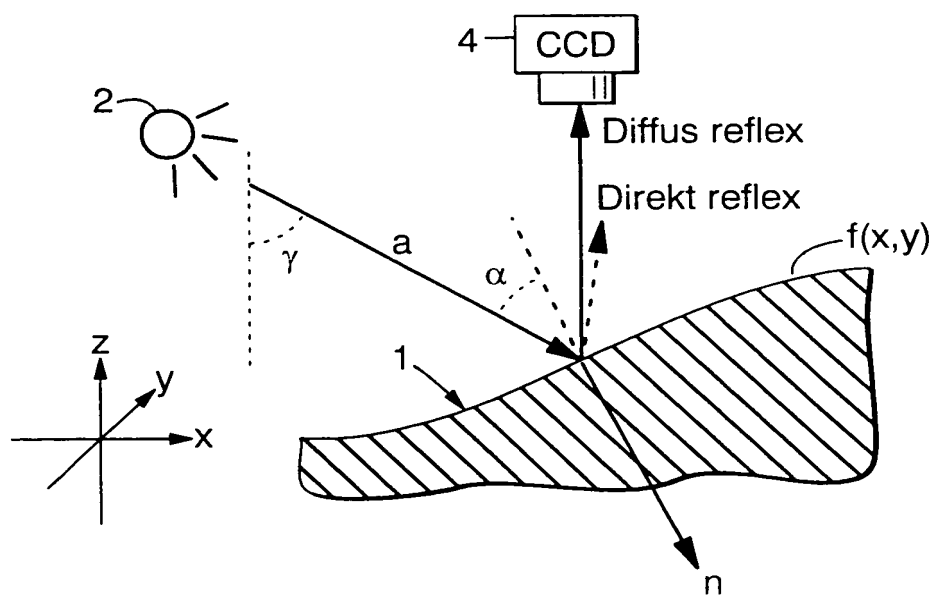


FIG. 2



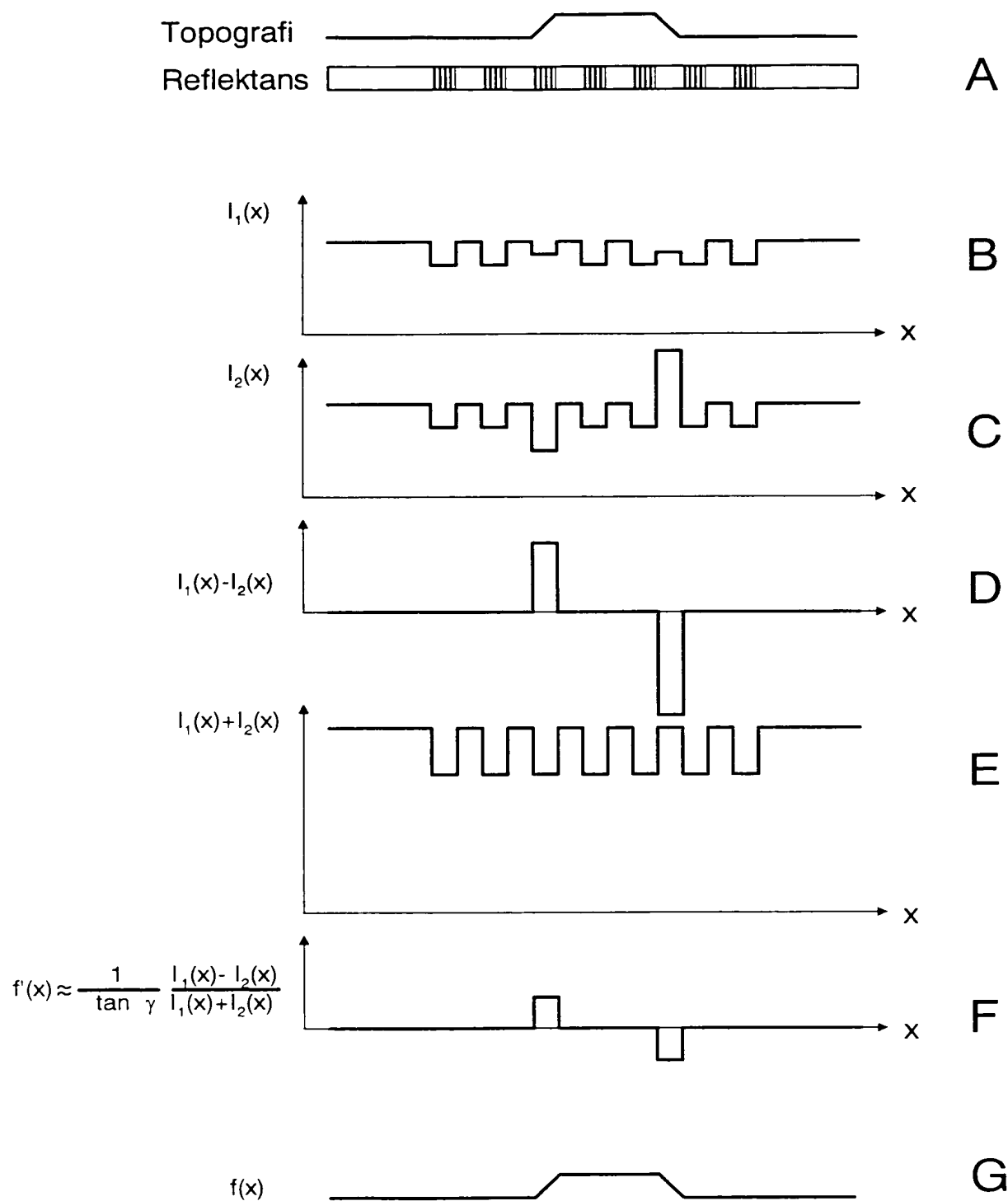


FIG.3



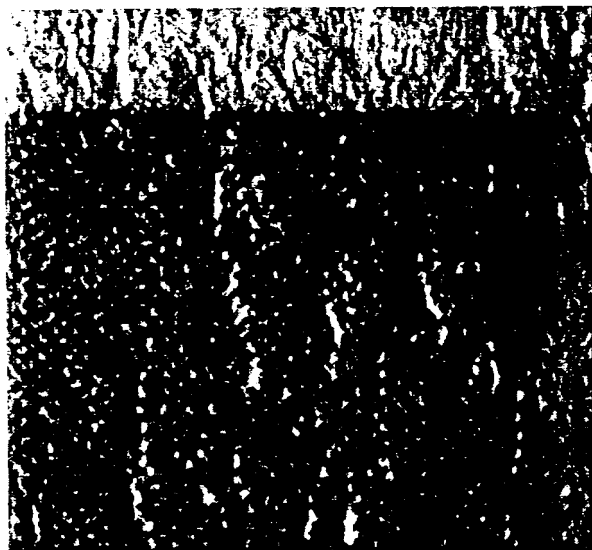


FIG. 4A

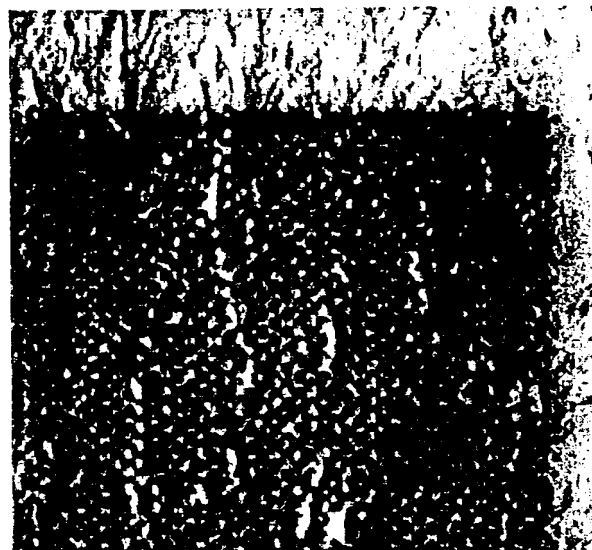


FIG. 4B

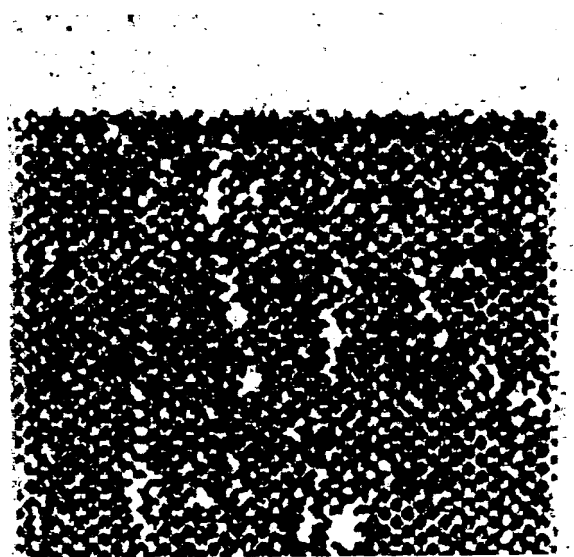


FIG. 5



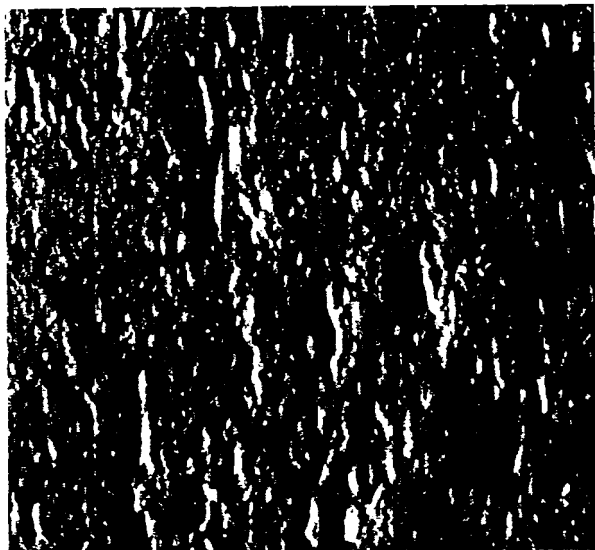


FIG.6



FIG.7

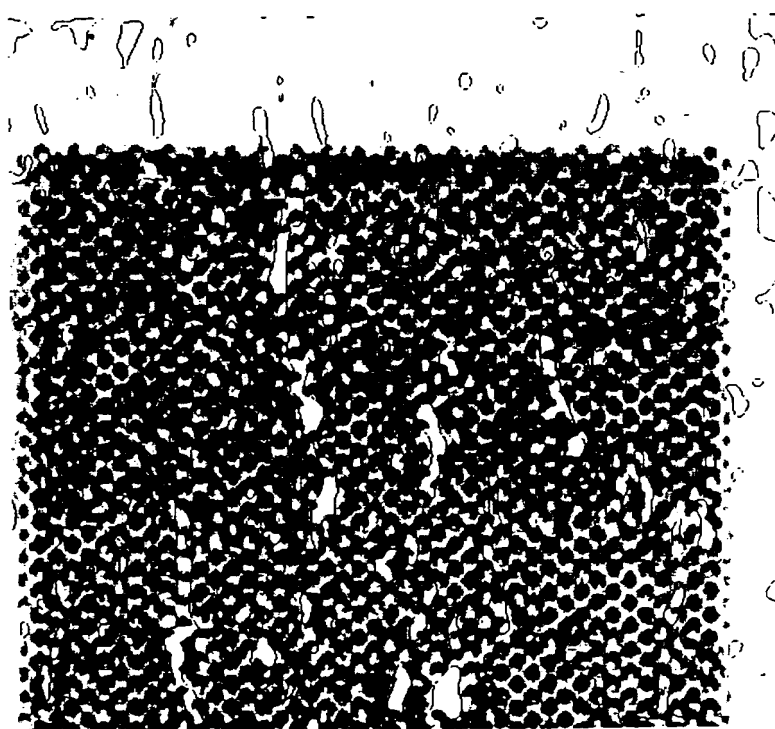


FIG.8





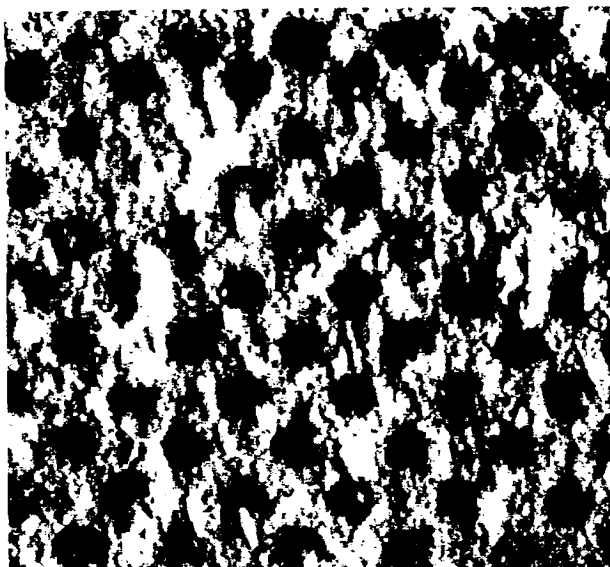


FIG.9A

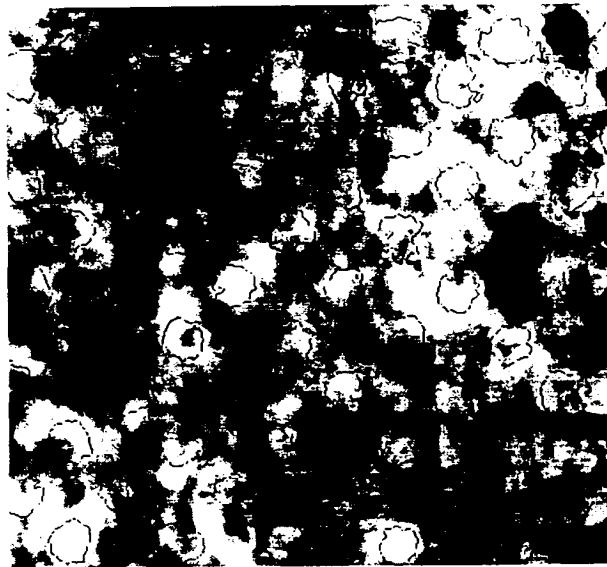


FIG.9B

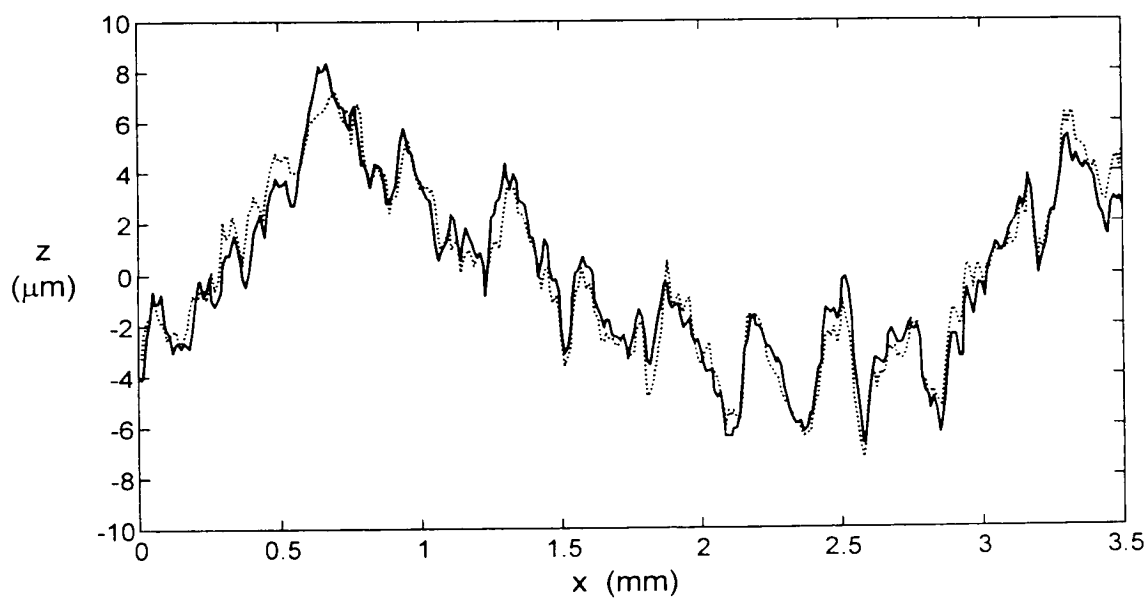


FIG.10



PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



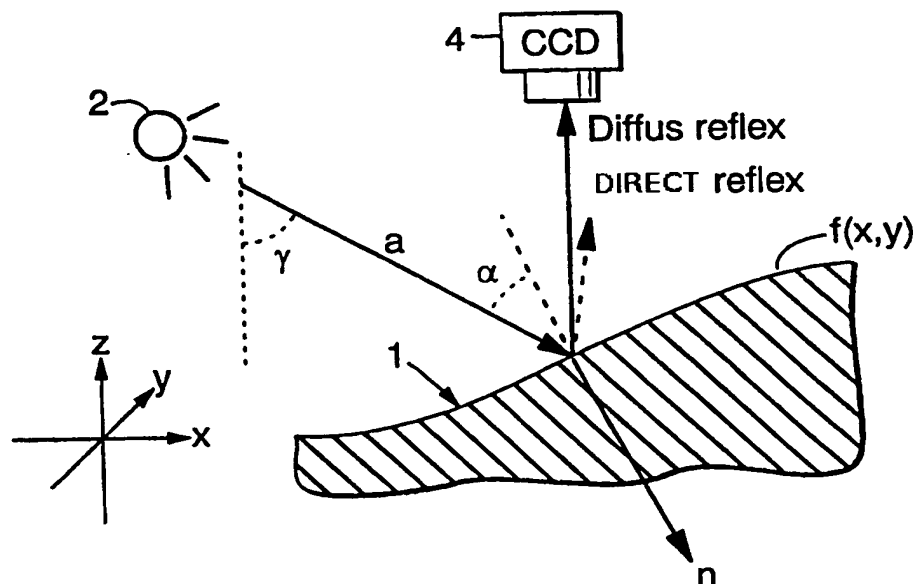
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : <b>G01B 11/29, 11/30</b>		A1	(11) International Publication Number: <b>WO 00/45125</b>
			(43) International Publication Date: 3 August 2000 (03.08.00)
(21) International Application Number: PCT/SE00/00024 (22) International Filing Date: 10 January 2000 (10.01.00) (30) Priority Data: 9900276-8 28 January 1999 (28.01.99) SE (71) Applicant (for all designated States except US): STFI [SE/SE]; Box 5604, S-114 86 Stockholm (SE). (72) Inventors; and (75) Inventors/Applicants (for US only): JOHANSSON, Per-Åke [SE/SE]; Dalagatan 20, S-113 24 Stockholm (SE). HANS- SON, Peter [SE/SE]; Genberg, Gårdsfogdevägen 29, S-161 70 Bromma (SE). (74) Agents: STEFAN, Lennefors et al.; AB Stockholms Patentbyrå, Zacco & Bruhn, Box 23101, S-104 35 Stockholm (SE).		(81) Designated States: AU, CA, JP, NZ, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the</i> <i>claims and to be republished in the event of the receipt of</i> <i>amendments.</i> <i>In English translation (filed in Swedish).</i>	

(54) Title: METHOD OF DETERMINING AN ILLUMINATED SURFACE

(57) Abstract

Method of determining a surface illuminated by incident light. First the intensity ( $I_1(x,y)$ ) of light reflected from the surface is recorded in a first image of the surface. After this, the intensity ( $I_2(x,y)$ ) of light reflected from the surface is recorded in a second image of the surface, taken at a different angle of illumination. Only the diffusely reflected light is recorded. The difference between the recorded intensities of the first and the second images is determined to obtain a representation that emphasises variations in gradient of the surface. This representation is further processed by signal-adapted integration to a topographic description, that is, a height function of the surface.





## Method of determining an illuminated surface

### TEKNIKOMRÅDE

- 5 Föreliggande uppfinning avser ett sätt att bestämma en av infallande ljus belyst yta genom registrering av intensiteten i reflekterat ljus från ytan hos en första bild därav och registrering av intensiteten i reflekterat ljus från ytan hos en andra, till ~~den~~ första bilden komplementär bild därav upptagen med annan belysningsvinkel.
- 10 Uppfinningen är speciellt men ej uteslutande tillämpbar på pappersytor avsedda att försees med påtryck.

### KÄND TEKNIK

- 15
- Genom SE 508 822 är kända ett förfarande och en anordning för mätning och kvantifiering av ytdefekter, såsom polerroisor som kan uppkomma i samband med polering av av lackerade plåt detaljer. Därvid registreras åtminstone två delbilder med minst en kamera under belysning av provytan med parallellt ljus eller punktljus, varvid ljusets infallsvinkel, i förhållande till provytan och/eller kameran är olika vid registrering av olika delbilder, varefter
- 20 registrerade delbilder behandlas i åtminstone en centralenhet. Därefter framställs en eller flera differensbilder av delbilderna och utnyttjas för att bestämma graden av ytdefekt på provytan. Denna kända teknik ger dock ej någon vägledning om hur de registrerade delbilderna kan utnyttjas för att topografiskt bestämma ytan.

25

### REDOGÖRELSE FÖR UPPFINNINGEN

- Ett ändamål med föreliggande uppfinning är att tillhandahålla en fotometrisk metod av in-
- 30 ledningsvis angivet slag som snabbt förmår topografiskt bestämma en yta.

**SUBSTITUTE SHEET**



Enligt en betraktelse av uppfinningen registreras intensiteten (dvs. effekten per ytenhet) av endast diffust reflekterat ljus hos de båda bilderna, och bestäms en skillnad mellan de registrerade intensiteterna av det diffust reflekterade ljuset hos de första och andra bilderna för erhållande av en representation av ytans lutningsvariationer.

5

Om skillnaden normeras genom division med summan av intensiteterna erhålls en kvot som är väsentligen direkt proportionell mot ytans lokala derivata.

Derivatans används i sin tur för beräkning av ytans höjdfunktion.

10

Insikten som ligger till grund för uppfinningen är att ljusheten hos ett topografiskt ytelement beror såväl av dess diffusa reflektans som dess vinkel i förhållande till belysningen. Om man upptar bilder av ytan med olika belysningsvinklar, så kommer dessa att skilja sig åt på grund av ytans topografi, men inte på grund av skillnader i diffus reflektans. Detta kan enligt uppfinningen utnyttjas i bildanalysoperationer som särskiljer topografien från reflektansen.

15

#### KORTFATTAD RITNINGSBESKRIVNING

20

Uppfinningen beskrivs mer i detalj med hänvisning till bifogad ritning, på vilken **FIG. 1** schematiskt visar ett arrangemang för bildregistrering enligt uppfinningen; **FIG. 2** visar motsvarande **FIG. 1** en modell som grund för bearbetningen av de registrerade bilderna; **FIG. 3** visar i diagramform ett förenklat exempel på bearbetning av en registrerad bild enligt uppfinningen; **FIG. 4A och B** visar bilder av en djuptyckt provyta registrerade genom belysning från vänster resp. höger hos ett arrangemang enligt **FIG. 1**; **FIG. 5** visar reflektans hos provytan enligt **FIG. 4**; **FIG. 6** visar derivatan hos provytan i **FIG. 4**; **FIG. 7** visar topografien hos provytan i **FIG. 4**; **FIG. 8** visar en bild av provytan enligt **FIG. 4** med nivåkurvor representerande  $-1 \mu\text{m}$ ; **FIG. 9A och B** visar i större skala en reflektansbild resp. en topografisk bild av en med tryckpunkter försedd provyta; och **FIG. 10** visar profiler av en provyta uppmätta mekaniskt resp. med ett arrangemang enligt uppfinningen.

30





## BESKRIVNING AV UTFÖRINGSEXEMPEL

5 I arrangemanget enligt FIG. 1 visas principen för uppfinningen. En provyta 1, som i de beskrivna exemplen är en pappersyta med en typisk area om 5x5 mm, belyses av en första ljuskälla 2 och av en andra ljuskälla 3 anordnade i två inbördes motsatta riktningar. Ljuskällorna 2 innefattar halogenlampor med belysningsoptik. En kamera 4 av CCD-typ detekterar och registrerar via en dator 5 intensiteten av det reflekterade ljuset.

10

Datorn 5 är företrädesvis försedd med känd maskin- och programvara för bildbehandling. Tidsåtgången för analys av en bild med en upplösning om 512x512 bildpunkter är för närvarande ca 10 s med en 400 MHz standard-PC. Den matematiska analysen har genomförts med MATLAB® programvara.

15

Uppfinningen baseras på detektering av diffust ljus. Spekulära reflexer från provytan kan elimineras i det visade exemplet medelst inbördes korsade polarisatorer 6 och 7. Närmare bestämt kan mellan provytan 1 och varje ljuskälla 2, 3 placeras en polarisator 6 och mellan provytan 1 och kameran 4 placeras en därtill korsad polarisator 7, på sådant sätt att belysningsljuset polariseras parallellt med infallsplanet och det reflekterade ljuset polariseras vinkelrätt därtill.

20

Med hänvisning till FIG. 2 är intensiteten hos det infallande ljuset proportionell mot  $\cos(\alpha)$ , där  $\alpha$  är belysningsljusets infallsvinkel mot ytan 1. För det diffust spridda ljuset antages  
25 Lamberts lag vara giltig. Enligt denna är radiansen lika i alla riktningar. Därför gäller för den av kameran 4 detekterade intensiteten att

$$I = I_0 R \cos(\alpha)$$

[1]

30

där  $R$  är reflektansen och  $I_0$  is den registrerade intensiteten när  $R = \cos(\alpha) = 1$ .

Genom skalär multiplikation erhålls värdet för  $\cos(\alpha)$  som



$$\cos(\alpha) = \mathbf{a} \cdot \mathbf{n} / |\mathbf{n}| = \frac{\sin(\gamma) \frac{\partial f}{\partial x} + \cos(\gamma)}{\sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2 + 1}} \quad [2]$$

där  $\mathbf{a}$  är belysningsvektorn  $[\sin(\gamma), 0, -\cos(\gamma)]$  och  $\mathbf{n}$  är ytnormalen  $[\partial f / \partial x, \partial f / \partial y, -1]$ .

- 5 Om två bilder  $I_1$  och  $I_2$ , med  $\gamma_2 = -\gamma_1$ , registreras, FIG. 4A, 4B, kan den partiella derivatan  $\partial f / \partial x$  beräknas med ledning av [1] och [2] som

$$\frac{\partial f}{\partial x} = \frac{1}{\tan \gamma} \frac{I_1 - I_2}{I_1 + I_2} \quad [3]$$

- 10 Detta uttryck är oberoende av reflektansen. Ett exempel på en derivata, beräknad med ledning av bilderna i FIG. 4A, B, visas i FIG. 6, där derivatan har kodats som en gråskalebild.

För att erhålla provytans höjdfunktion, behöver derivatan integreras, men eftersom bilderna innehåller brus, behöver vissa spatiala frekvenser integreras med försiktighet. Därför bör

- 15 företrädesvis derivatan Fouriertransformeras och multipliceras med ett s.k. Wienerfilter:

$$H_R = \frac{H_I^*}{|H_I|^2 + \text{SNR}(u, v)^{-1}} \quad [4]$$

som utför integreringen med undertryckande av spatiala frekvenser  $u$  och  $v$ , vilka har ett förväntat lågt signal-brusförhållande SNR. Ytans frekvenssvar  $H_I$  innefattar både den partiella derivatan (i form av  $2\pi i u$ ) och det i materialet spridda ljuset. För närmare beskrivning av ett Wienerfilter hänvisas till Pratt, W. K., (1978), Digital Image Processing, Wiley, New York, 378-387. Ytfunktionen, som visas i FIG. 7, likaså kodad som en gråskalebild där lägre ytområden har en mörkare ton än höga ytområden, erhålls genom invers transformation av produkten.

25

Provytans lokala reflektans, som tillhandahåller information om påtryckets täckningsgrad, erhålls approximativt som summan av bilderna,  $I_1$  och  $I_2$ , se FIG. 5.

- 30 För att underlätta förståelsen av uppfinningen, visas på FIG. 3 A-G en förenklad endimensionell "digital" betraktelse av en typisk bildbehandlingsoperation.



FIG. 3 A visar den provyta vars topografi  $f(x)$  skall undersökas. Ytan har i detta fall ett påtryckt regelbundet mönster.

- 5 När ytan belyses med strykljus från vänster erhålls enligt FIG. 3B till följd av variationer i såväl reflektans (mönstret) som topografi, en intensitetsvariation i det diffust reflekterade ljuset. Jämför även motsvarande bild eller grafiska representation i det tvådimensionella fallet enligt FIG. 4A där intensitetsvariationen motsvaras av variation i gråskala.
- 10 När ytan belyses med strykljus från höger erhålls på motsvarande sätt enligt FIG. 3C en ny intensitetsvariation  $I_2(x)$  i det diffust reflekterade ljuset. Jämför även motsvarande bild i det tvådimensionella fallet enligt FIG. 4B.

- 15 Beräknas skillnaden,  $I_1(x) - I_2(x)$  mellan intensiteterna, erhålls enligt FIG. 3D en variation som framhäver topografiska variationer (reflektansvariationerna undertrycks delvis men ej helt), dvs. variationer i ytans lutning.

- 20 Beräknas summan  $I_1(x) + I_2(x)$  av intensiteterna erhålls enligt FIG. 3E en variation som väsentligen endast beror av reflektansvariationer, medan de strukturella eller topografiska variationerna undertrycks. Med andra ord erhålls ytans färgfördelning, t.ex. förekomst eller inte förekomst av påtryck. Jämför även motsvarande bild i det tvådimensionella fallet enligt FIG. 5.

- 25 Beräknas kvoten  $(I_1(x) - I_2(x))/(I_1(x) + I_2(x))$ , dvs den normerade skillnaden mellan intensiteterna, erhålls enligt FIG. 3F en variation som väsentligen endast beror av topografiska variationer, dvs. variationer i ytans lutning.

Kvoten används för beräkning av ytans derivata enligt FIG. 3F som

$$f'_x(x) \approx \frac{1}{\tan \gamma} \cdot \frac{I_1(x) - I_2(x)}{I_1(x) + I_2(x)}$$



där liksom tidigare  $\gamma$  = belysningsljusets infallsvinkel. Jämför även motsvarande bild i det tvådimensionella fallet enligt FIG. 6. I det tvådimensionella fallet blir derivatan på motsvarande sätt

$$f'_x(x, y) \approx \frac{1}{\tan \gamma} \cdot \frac{I_1(x, y) - I_2(x, y)}{I_1(x, y) + I_2(x, y)}$$

- 5 Integreras derivatan, företrädesvis med ovan beskriven samtidig anpassad brusundertryckning, erhålls ytans topografi enligt FIG. 3G. Jämför även motsvarande bild i det tvådimensionella fallet enligt FIG. 7.

Som framgår av det föregående kan, förutom den rena topografiska bestämningen (FIG. 7) av en yta, uppfinningen sålunda även användas för samtidig bestämning av ytans reflektans (FIG. 5) i samma koordinater. Därmed kan intressanta samband mellan ytstruktur och färgöverföring studeras i detalj. På reflektansbilden i FIG. 5 har i FIG. 8 genom tröskeloperation i den bildanalyserande datorn 5 införts nivåkurvor motsvarande ett djup om  $-1 \mu\text{m}$  från en glidande referensnivå, vilket kan förklara varför tryckpunkter saknas i partier av tryckområdet. På provytan enligt FIG. 9A och B har på motsvarande sätt undersökts om ett bestämt djup hos försänkningarna (t.ex. mörka partier i vänstra övre delen av topografikartan FIG. 9B) i ytan kan motsvara utebliven färgöverföring (uteblivna färgpunkter i FIG. 9A i de partier som är mörkast i FIG. 9B). Detta kan inom trycktekniken utnyttjas som en förutsägelse om på vilka ställen missade tryckpunkter kan förväntas.

20

Det har därvid visat sig att s.k. rak tröskelsättning i topografin ej fungerar så bra. Om man däremot högpasfilterar topografin så att långvågig information undertrycks och därefter applicerar en tröskel på  $-1 \mu\text{m}$ , dvs. i praktiken tröskling relativt en glidande referensnivå, så markeras områden som har hög sannolikhet för utebliven färgöverföring, se FIG. 8. Av detta kan man alltså lära sig mer om hur ytråhet skall mätas på ett tryckbarhetsrelevant sätt. Metoden har också gett intressanta resultat för fulltonsytor tryckta i flexo (ej visat).

De två bilderna behöver ej nödvändigtvis registreras vid skilda tidpunkter. Exempelvis kan med det beskrivna arrangemanget enligt FIG. 1 den ena bilden registreras i ett första ljusvåglängdsområde och den andra bilden från samma kamerapunkt samtidigt registreras i

30





ett andra, till det första våglängdsområdet komplementärt eller skilt våglängdsområde (ej visat) om de två belysningarna använder skilda våglängdsområden. Därigenom erbjuds möjlighet att registrera förlopp då provytan, t.ex. ett område av en pappersbana under produktion, befinner sig i rörelse.

5

Analyser enligt uppfinningen av provstycken av LWC-papper har visat god korrelation,  $r^2=0,95$ , mellan profiler bestämda enligt uppfinningen och profiler bestämda enligt konventionella optiska eller mekaniska profilmätmetoder. I det i FIG. 10 visade diagrammet anger den heldragna kurvan profilen bestämd enligt uppfinningen, medan den streckade kurvan anger samma profil hos samma pappersremsa bestämd genom en mekanisk kontaktmätmetod.

10

.....



## PATENTKRAV

1. Sätt att bestämma en av infallande ljus belyst yta genom registrering av intensiteten ( $I_1(x,y)$ ) i reflekterat ljus från ytan hos en första bild därav och registrering av intensiteten ( $I_2(x,y)$ ) i reflekterat ljus från ytan hos en andra, till den första bilden komplementär bild därav upptagen med annan belysningsvinkel, k ä n n e t e c k n a t av
- 5 registrering av intensiteten av endast diffust reflekterat ljus över ytan hos de båda bilderna, och
- bestämning av en skillnad mellan de registrerade intensiteterna av det diffust reflekterade ljuset över ytan hos de första och andra bilderna för erhållande av en representation som framhäver lutningsvariationer hos ytan.
- 10
2. Sätt enligt krav 1, k ä n n e t e c k n a t av att skillnaden normeras för erhållande av en en reflektansneutral bild som representerar lutningsvariationer, dvs. en derivata av ytans höjdfunktion.
- 15
3. Sätt enligt krav 2, k ä n n e t e c k n a t av att skillnaden normeras genom division med en summa ( $I_1(x,y) + I_2(x,y)$ ) av de registrerade intensiteterna över ytan.
- 20
4. Sätt enligt [något] krav 3, k ä n n e t e c k n a t av att summan ( $I_1(x,y) + I_2(x,y)$ ) av de registrerade intensiteterna över ytan används för erhållande av en väsentligen topografiskt neutral reflektansbild av ytan.
5. Sätt enligt något av föregående krav, k ä n n e t e c k n a t av att intensiteten hos den första bilden registreras med ljus infallande från en första riktning och att intensiteten hos den andra bilden registreras med ljus infallande från en andra, till den första riktnings reflektionsvinkel motsatt riktning.
- 25
6. Sätt enligt något av föregående krav, k ä n n e t e c k n a t av beräkning av ytans derivata genom
- 30

$$f'_x(x,y) \approx \frac{1}{\tan \gamma} \cdot \frac{I_1(x,y) - I_2(x,y)}{I_1(x,y) + I_2(x,y)}$$



där  $\gamma$  är ljusets infallsvinkel.

7. Sätt enligt krav 6, k ä n n e t e c k n a t av Fouriertransformation av derivatan och multiplikation därav med ett Wienerfilter för undertryckning av brus i de registrerade intensiteterna.
8. Sätt enligt krav 6 eller 7, k ä n n e t e c k n a t av integrering av derivatan för erhållande av ytans höjdfunktion.
9. Sätt enligt något av föregående krav, k ä n n e t e c k n a t av polarisering av det infallande ljuset och därtill korsande polarisering av det reflekterade ljuset för att eliminera reflexer i ytan och erhålla nämnda diffust reflekterade ljus.
10. Sätt enligt något av föregående krav, k ä n n e t e c k n a t av att den första bilden registreras med ljus i ett första ljusvåglängdsområde och att den andra bilden registreras med ljus i ett andra, från det första ljusvåglängdsområdet skilt ljusvåglängdsområde.
11. Sätt enligt krav 10, k ä n n e t e c k n a t av att den första bilden registreras genom belysning med ljus av en första frekvens, och att den andra bilden registreras genom belysning med ljus av en, från den första frekvensen avvikande frekvens.
12. Sätt enligt krav 10 eller 11, k ä n n e t e c k n a t av att den första och den andra bilden registreras samtidigt.
13. Användning av ett sätt enligt något av föregående krav för topografisk bestämning av en pappersyta.
-



## SAMMANDRAG

Sätt att bestämma en av infallande ljus belyst yta. Först registreras intensiteten ( $I_1(x,y)$ ) av reflekterat ljus från ytan hos en första bild av ytan. Därefter registreras av intensiteten ( $I_2(x,y)$ ) av reflekterat ljus från ytan hos en andra bild av ytan, upptagen med annan belysningsvinkel. Endast det diffust reflekterade ljuset registreras. Skillnaden mellan de registrerade intensiteterna hos den första och andra bilden bestäms för erhållande av en representation som framhäver lutningsvariationer hos ytan. Denna representation vidarebearbetas genom signalanpassad integrering till en topografisk beskrivning, dvs. en höjdfunktion av ytan.

(FIG. 2)

-----





## PCT COOPERATION TREATY

PCT

INFORMATION CONCERNING ELECTED  
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

From the INTERNATIONAL BUREAU

To:

STEFAN, Lennefors  
AB Stockholms Patentbyrå, Zacco &  
Bruhn  
Box 23101  
S-104 35 Stockholm  
SUÈDE

Date of mailing (day/month/year) 30 October 2000 (30.10.00)		IMPORTANT INFORMATION	
Applicant's or agent's file reference 103375101			
International application No. PCT/SE00/00024	International filing date (day/month/year) 10 January 2000 (10.01.00)	Priority date (day/month/year) 28 January 1999 (28.01.99)	
Applicant STFI et al			

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE  
National : AU, CA, JP, NZ, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

None

3. The applicant is reminded that he must enter the "national phase" **before the expiration of 30 months from the priority date** before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed **until 31 months from the priority date** for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No. (41-22) 740.14.35	Authorized officer:  Charlotte ENGER  Telephone No. (41-22) 338.83.38
--	---



## PATENT COOPERATION TREATY

PCT

NOTICE INFORMING THE APPLICANT OF THE  
COMMUNICATION OF THE INTERNATIONAL  
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:

STEFAN, Lennefors  
AB Stockholms Patentbyrå, Zacco &  
Bruhn  
Box 23101  
S-104 35 Stockholm  
SUÈDE

Date of mailing (day/month/year)

03 August 2000 (03.08.00)

Applicant's or agent's file reference

103375101

## IMPORTANT NOTICE

International application No.

PCT/SE00/00024

International filing date (day/month/year)

10 January 2000 (10.01.00)

Priority date (day/month/year)

28 January 1999 (28.01.99)

Applicant

STFI et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:

AU,JP,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

CA,EP,NZ

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on

03 August 2000 (03.08.00) under No. WO 00/45125

**REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)**

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a **demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

**REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))**

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Authorized officer

J. Zahra

Facsimile No. (41-22) 740.14.35

Telephone No. (41-22) 338.83.38



331130/370177 25 JUL 2001

Method of determining an illuminated surface

## TECHNICAL AREA

- 5 The present invention relates to a method of determining a surface illuminated by incident light by recording the intensity of light reflected from the area in a first image thereof and recording the intensity of light reflected from the area in a second image thereof, complementary to the first image, taken with another angle of illumination.
- 10 The invention is particularly but not exclusively applicable to paper surfaces intended for the application of print.

## THE PRIOR ART

15

- SE 508 822 makes known a method and a device for measuring and quantifying surface defects, such as polishing roses that can occur in connection with the polishing of coated sheet metal items. In this method and device, at least two sub-images are recorded with at least one camera under illumination of the test surface with parallel light or light from
- 20 a point source, whereby the angles of incidence of the light relative to the test surface and/or the camera are different during the recording of different sub-images, after which the sub-images are processed in at least one central unit. After this, one or several difference images of the sub-images are produced, and used to determine the degree of surface defects on the test surface. This known technique, however, provides no
- 25 guidance in how the recorded sub-images can be used in order to determine the topography of the surface.

## DESCRIPTION OF THE INVENTION

30

An object of the present invention is to provide a photometric method of the type described in the introduction that can rapidly determine the topography of a surface.

According to an aspect of the invention, the intensity (that is, the power per unit area) only of diffusely reflected light is recorded in the two images, and a difference between the recorded intensities of the diffusely reflected light of the first and the second recorded  
5 images is determined, in order to obtain a representation of the gradient variations of the surface.

If the difference is normalised by division by the sum of the intensities, a ratio is obtained that is essentially directly proportional to the local derivative of the surface.  
10

The derivative in turn is used to determine the height function of the surface.

The insight that forms the basis of the invention is that the lightness of a topographic surface element depends both on its diffuse reflectance and on its angle relative to the  
15 illumination. If images of the surface are taken with different angles of illumination, these will differ due to the topography of the surface, but not due to differences in its diffuse reflectance. This can, according to the invention, be used in image processing operations that distinguish the topography from the reflectance.

20

## BRIEF DESCRIPTION OF DRAWINGS

The invention is described in more detail with reference to the attached drawings, in which **FIG. 1** shows schematically an arrangement for recording images according to the  
25 invention; **FIG. 2** shows a model corresponding to **FIG. 1** that forms the basis for processing the recorded images; **FIG. 3** shows in the form of a diagram a simplified example of processing a recorded image according to the invention; **FIGS. 4A and 4B** show images of a deeply printed test surface recorded by illumination from the left and from the right of the arrangement according to **FIG. 1**; **FIG. 5** shows the reflectance of  
30 the test surface according to **FIG. 4**; **FIG. 6** shows the derivative of the test surface in **FIG. 4**; **FIG. 7** shows the topography of the test surface in **FIG. 4**; **FIG. 8** shows an image of the test surface according to **FIG. 4** with contours representing  $-1 \mu\text{m}$ ; **FIGS.**

9A and 9B show at a higher scale a reflectance image and a topographic image, respectively, of a test surface furnished with printed points; and FIG. 10 shows profiles of a test surface measured mechanically and measured with an arrangement according to the invention.

5

## DESCRIPTION OF AN EMBODIMENT

10 The principle of the invention is shown in the arrangement according to FIG. 1. A test surface 1, which in the examples described is a paper surface with an area typically of 5x5 mm, is illuminated by a first light source 2 and by a second light source 3 arranged at two mutually opposite directions. The light sources 2, 3 contain halogen lamps with illumination optics. A camera 4 of CCD type detects and records by a computer 5 the  
15 intensity of the reflected light.

The computer 5 is preferably equipped with known hardware and software for image processing. The time required for analysis of an image with a resolution of 512x512 pixels is currently approximately 10 seconds using a 400 MHz standard PC. The  
20 mathematical analysis has been carried out using the MATLAB® software.

The invention is based on the detection of diffuse light. Specular reflections from the test surface can be eliminated in the example shown by means of mutually crossed polarizers 6 and 7. In more detail, a polarizer 6 can be placed between the test surface 1 and each  
25 light source 2, 3, while a polarizer 7 that is crossed with respect to the polarizer 6 can be placed between the test surface 1 and the camera 4, in such a way that the illuminating light is polarised parallel to the incident plane and the reflected light is polarised at right angles to it.

30 With reference to FIG. 2, the intensity of the incident light is proportional to  $\cos(\alpha)$ , where  $\alpha$  is the angle of incidence of the illuminating light to the surface 1. Lambert's law

is assumed to be valid for the diffusely spread light. According to this law, the radiance is equal in all directions. This means that the intensity detected by the camera is given by

$$I = I_0 R \cos(\alpha) \quad [1]$$

where  $R$  is the reflectance and  $I_0$  is the intensity measured when  $R = 1$  and  $\cos(\alpha) = 1$ . Scalar multiplication gives a value for  $\cos(\alpha)$  as

$$\cos(\alpha) = \mathbf{a} \cdot \mathbf{n} / |\mathbf{n}| = \frac{\sin(\gamma) \frac{\partial f}{\partial x} + \cos(\gamma)}{\sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2 + 1}} \quad [2]$$

where  $\mathbf{a}$  is the illumination vector  $[\sin(\gamma), 0, -\cos(\gamma)]$  and  $\mathbf{n}$  is the surface normal  $[\partial f / \partial x, \partial f / \partial y, -1]$

- 15 If two images,  $I_1$  and  $I_2$ , are recorded with  $\gamma_2 = -\gamma_1$ , FIGS. 4A, 4B, the partial derivative  $\partial f / \partial x$  can be calculated from [1] and [2] as

$$\frac{\partial f}{\partial x} = \frac{1}{\tan \gamma} \frac{I_1 - I_2}{I_1 + I_2} \quad [3]$$

- 20 This expression does not depend on the reflectance. An example of the derivative, calculated from the images in FIGS. 4A, 4B, is shown in FIG. 6, in which the derivative has been coded as a grey-scale image.

- In order to obtain the height function of the test surface, the derivative must be  
25 integrated. However, since the images contain noise, certain spatial frequencies must be integrated with caution. This is why the derivative should preferably be subjected to a Fourier transform and multiplied by what is known as a Wiener filter:

$$H_R = \frac{H_I^*}{|H_I|^2 + \text{SNR}(u, v)^{-1}} \quad [4]$$

- 30 which performs the integration with the suppression of spatial frequencies  $u$  and  $v$ , which have an expected low signal-to-noise ration, SNR. The frequencies  $H_I$  of the surface



include both the partial derivative (in the form of  $2\pi u$ ) and the light that is spread in the material. For more detailed description of a Wiener filter, refer to *Pratt, W. K., (1978), Digital Image Processing, Wiley, New York, 378-387*. The surface function, which is shown in FIG. 7, also coded as a grey-value image in which lower surface areas have a darker grey value than higher surface areas, is obtained as the inverse transform of the product.

The local reflectance of the test surface, which provides information about the degree of covering of the print, is approximately obtained as the sum of the images,  $I_1$  and  $I_2$ , see FIG. 5.

In order to facilitate understanding of the invention, a simplified one-dimensional "digital" observation of a typical image processing operation is shown in FIGS. 3 A-G.

FIG. 3A shows the test surface, the topography of which,  $f(x)$ , is to be investigated. In this case the surface has a printed regular pattern.

When the surface is illuminated with oblique illumination from the left, an intensity variation in the diffusely reflected light is obtained, according to FIG. 3B, as a result of variations both in the reflectance (the pattern) and in the topography. Compare also the equivalent image or graphical representation in the two-dimensional case according to FIG. 4A, in which variations in grey-value are equivalent to variations in intensity.

When the surface is illuminated with oblique illumination from the right, a new intensity variation,  $I_2(x)$ , in the diffusely reflected light is obtained in an equivalent manner, according to FIG. 3C. Compare also the equivalent image in the two-dimensional case according to FIG. 4B.

If the difference between the intensities,  $I_1(x) - I_2(x)$ , is calculated, a variation which accentuates the topographic variations is obtained, according to FIG. 3D (the variations in reflectance are partially, but not wholly, suppressed), that is, variations in the gradient of the surface.

If the sum of the intensities,  $I_1(x) + I_2(x)$ , is calculated, a variation that essentially depends only on variations in reflectance is obtained according to FIG. 3E, while the structural or topographical variations are suppressed. In other words, the distribution of colour on the surface is obtained, that is, the presence or absence of print. Compare also the equivalent image in the two-dimensional case according to FIG. 5.

If the ratio  $(I_1(x) - I_2(x))/(I_1(x) + I_2(x))$  is calculated, that is, the normalised difference between the intensities, a variation is obtained according to FIG. 3F that essentially only depends on topographic variations, that is, variations in the gradient of the surface.

The ratio is used to calculate the derivative of the surface according to FIG. 3F as

$$f'_x(x) \approx \frac{1}{\tan \gamma} \cdot \frac{I_1(x) - I_2(x)}{I_1(x) + I_2(x)}$$

where  $\gamma$  = the angle of incidence of the illumination, as previously. Compare also the equivalent image in the two-dimensional case according to FIG. 6. In the two-dimensional case the derivative will in an equivalent way become

$$f'_x(x, y) \approx \frac{1}{\tan \gamma} \cdot \frac{I_1(x, y) - I_2(x, y)}{I_1(x, y) + I_2(x, y)}$$

If the derivative is integrated, preferably with the simultaneous suppression of noise as described above, the topography is obtained according to FIG. 3G. Compare also the equivalent image in the two-dimensional case according to FIG. 7.

As the previous description has made clear, in addition to the purely topographic determination (FIG. 7) of a surface, the invention can also be used for the simultaneous determination of the reflectance of the surface (FIG. 5) in the same co-ordinates. In this way, interesting relationships between surface structure and the transfer of print can be studied in detail. In FIG. 8, contours equivalent to a depth of  $-1 \mu\text{m}$  from a sliding reference level have been added to the reflectance image from FIG. 5 by a thresholding operation in the image processing computer 5, which explains why printed points are

missing from regions of the printed area. In a similar manner, an examination has been made on the test surface according to FIGS. 9A and 9B whether a particular depth of the depressions in the surface (for example, dark regions in the upper left-hand corner of the topographical map FIG. 9B) can correspond to failed print transfer (missing print points in FIG. 9A in those regions that are darkest in FIG. 9B). This can be used in printing technology as a prediction about in which regions missing printed points can be expected.

In this respect it has become evident that so-called straight thresholding of the topography does not work so well. On the other hand, if a high-pass filter is applied to the topographical map such that long wavelength information is suppressed, and then apply a threshold level of  $-1\text{ }\mu\text{m}$ , that is to say, in practice thresholding relative to a sliding reference level, then the areas that have a high probability for missing print transfer are marked, see FIG. 8. It is possible to learn from this more about how surface roughness should be measured in a manner that is relevant for printability. The method has also given interesting results for full-tone areas printed flexographic printing (not shown).

It is not necessary that the two images be recorded at different times. For example, the first image can be recorded with the arrangement described in FIG. 1 in a first wavelength region and the second image can be simultaneously recorded from the same camera point in a second wavelength region, complementary or distinct from the first wavelength region (not shown), if the two illuminations use distinct wavelength regions. In this way the possibility of recording processes on the test surface, for example, a region of a paper pathway during production, which is in motion.

Analyses according to the invention of test pieces of LWC paper have shown a high correlation,  $r^2=0.95$ , between profiles determined according to the invention and profiles determined according to conventional optical and mechanical methods of measuring profiles. In the diagram shown in FIG. 10, the full curve shows the profile determined according to the invention, while the dashed curve shows the same profile of the same paper strip determined by a mechanical contact method of measuring.

## CLAIMS

1. A method for determining a surface illuminated by incident light by recording the intensity ( $I_1(x,y)$ ) in light reflected from the surface in a first image thereof  
5 and by recording the intensity ( $I_2(x,y)$ ) in light reflected from the surface in a second image thereof, taken with another angle of illumination and complementary to the first image, c h a r a c t e r i s e d by  
recording the intensity of only diffusely reflected light over the surface in the two images, and  
10 determination of the difference between the recorded intensities of diffusely reflected light over the surface in the first and second images in order to obtain a representation that emphasises variations in gradient of the surface.
2. The method according to claim 1, c h a r a c t e r i s e d in that the  
15 difference is normalised in order to obtain an image that is reflectance-neutral and which represents variations in gradient, that is, a derivative of the height function of the surface.
3. Method according to claim 2, c h a r a c t e r i s e d in that the  
20 difference is normalised by division by a sum ( $I_1(x,y) + I_2(x,y)$ ) of the recorded intensities of the surface.
4. The method according to [some] claim 3, c h a r a c t e r i s e d in that  
the sum ( $I_1(x,y) + I_2(x,y)$ ) of the recorded intensities over the surface is used to obtain an  
25 essentially topographically neutral reflectance image of the surface.
5. The method according to any of the previous claims,  
c h a r a c t e r i s e d in that the intensity of the first image is recorded with light  
incident from a first direction and that the intensity of the second image is recorded with  
30 light incident from a second direction that is opposite to the reflection angle of the first direction.

6. The method according to any of the previous claims,  
c h a r a c t e r i s e d by calculation of the derivative of the area by

$$f'_x(x, y) \approx \frac{1}{\tan \gamma} \cdot \frac{I_1(x, y) - I_2(x, y)}{I_1(x, y) + I_2(x, y)}$$

where  $\gamma$  is the angle of incidence of the light.

5

7. The method according to claim 6, c h a r a c t e r i s e d by Fourier transformation of the derivative and multiplication thereof by a Wiener filter in order to suppress noise in the recorded intensities.

10 8. The method according to claim 6 or 7, c h a r a c t e r i s e d by integration of the derivative in order to obtain the height function of the surface.

9. The method according to any of the preceding claims,  
c h a r a c t e r i s e d by polarisation of the incident light and thereto crosswise  
15 polarisation of the reflected light in order to eliminate reflections in the surface and obtain the said diffusely reflected light.

10. The method according to any of the preceding claims,  
c h a r a c t e r i s e d in that the first image is recorded with light in a first  
20 wavelength region and that the second image is recorded with light in a second wavelength region, distinct from the first wavelength region.

11. The method according to claim 10, c h a r a c t e r i s e d in that the  
first image is recorded by illumination with light of a first frequency and that the second  
25 image is recorded by illumination with light of a second frequency that deviates from the first frequency.

12. The method according to claim 10 or 11, c h a r a c t e r i s e d in that  
the first and the second images are recorded simultaneously.

30

13. Use of the method according to any of the preceding claims for determining the topography of a paper surface.

-----

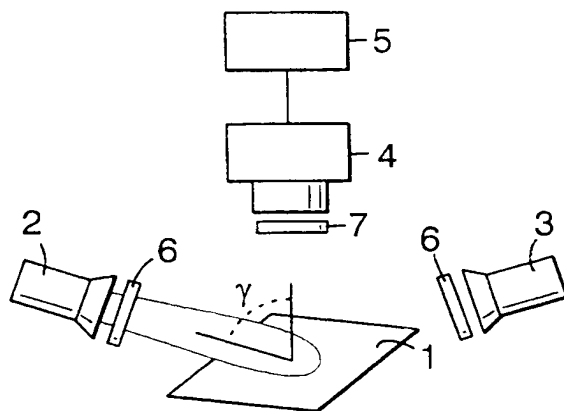


FIG. 1

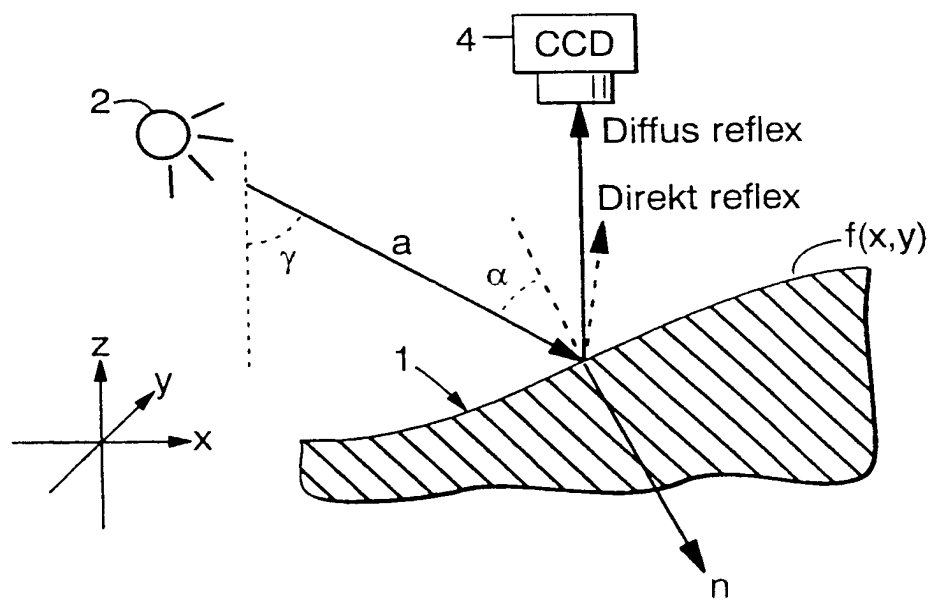


FIG. 2

381025 0100

25 JUL 2001



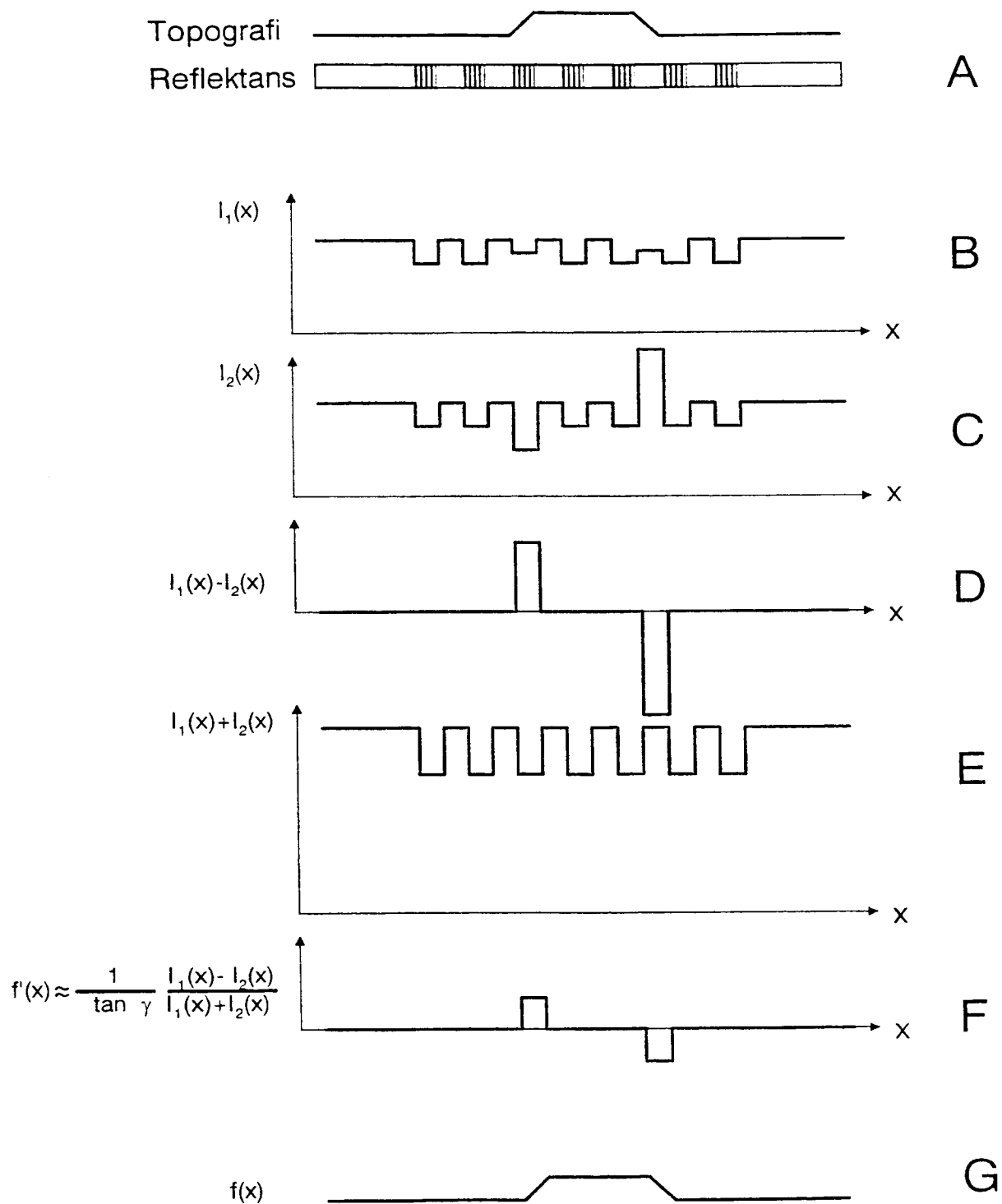


FIG.3

531 Road FC77

25 JUL 2001

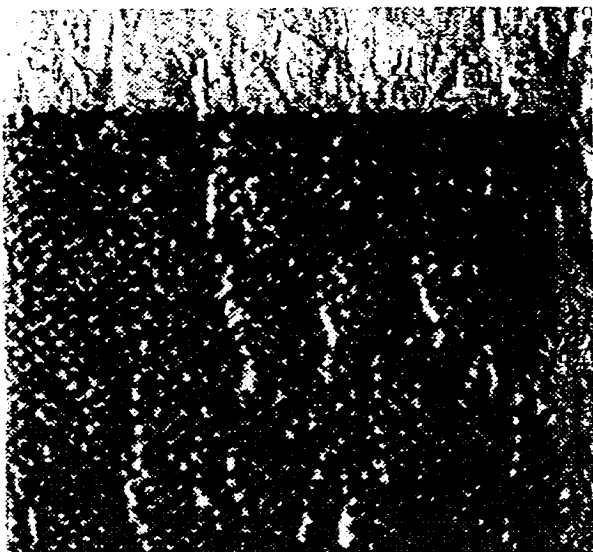


FIG. 4A



FIG. 4B

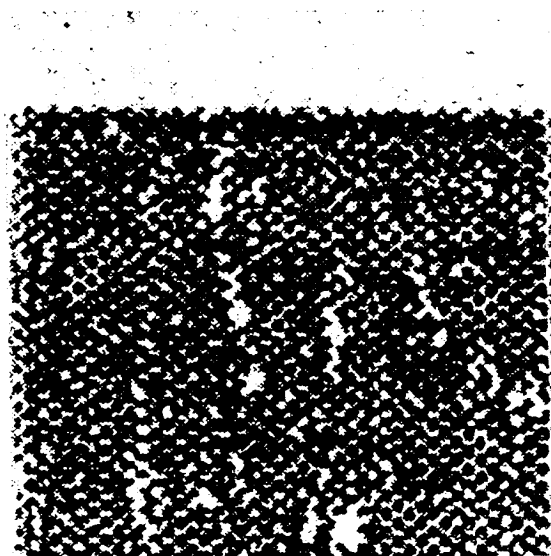


FIG. 5

58174

101001

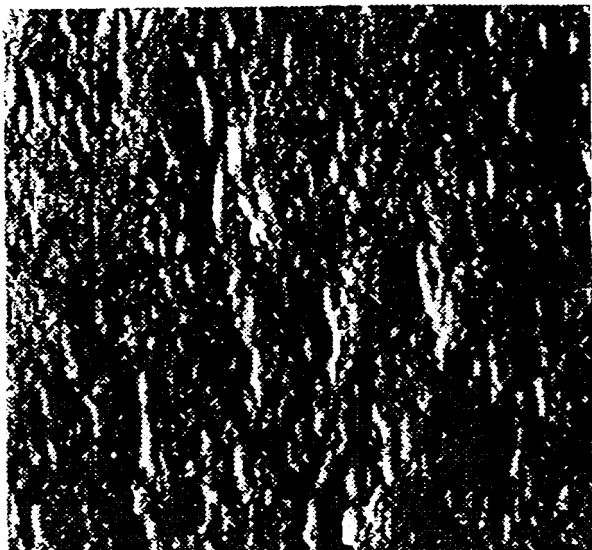


FIG.6



FIG.7

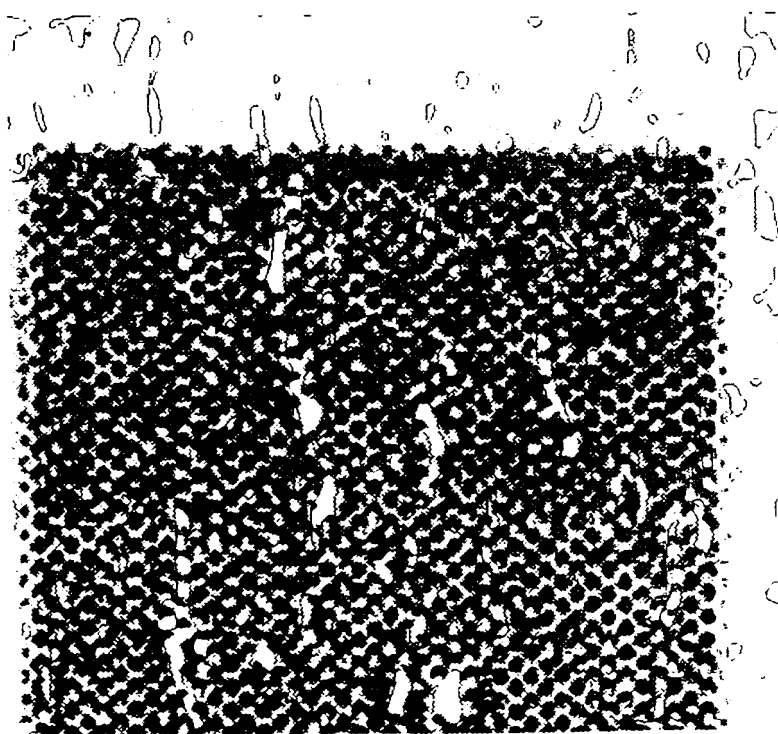


FIG.8

531 Rev. 5/91 25 JUL 2001

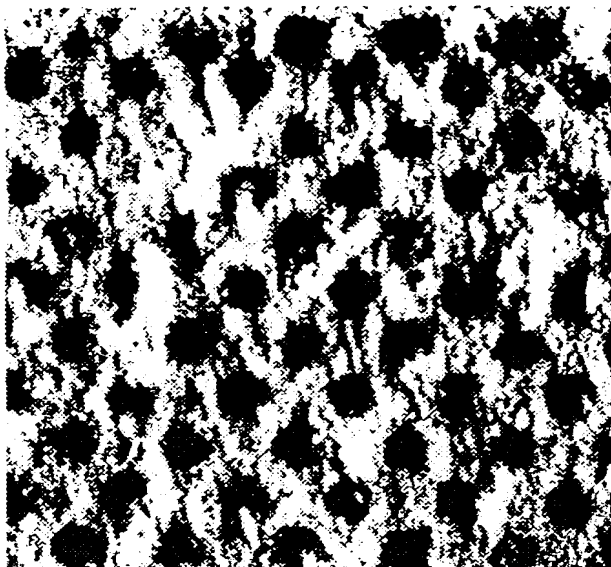


FIG.9A

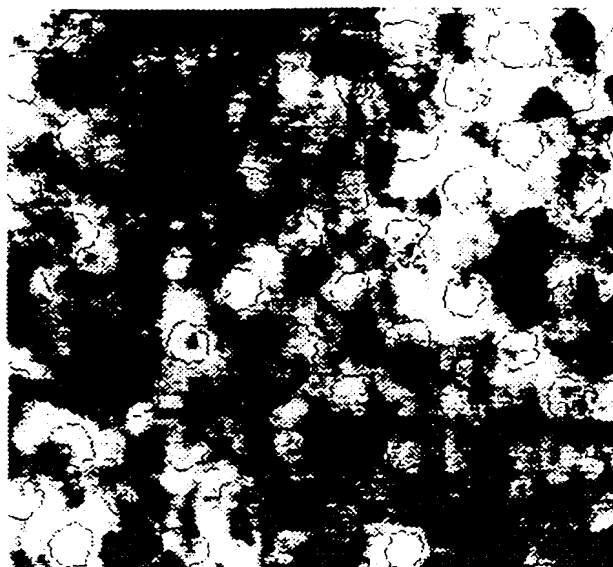


FIG.9B

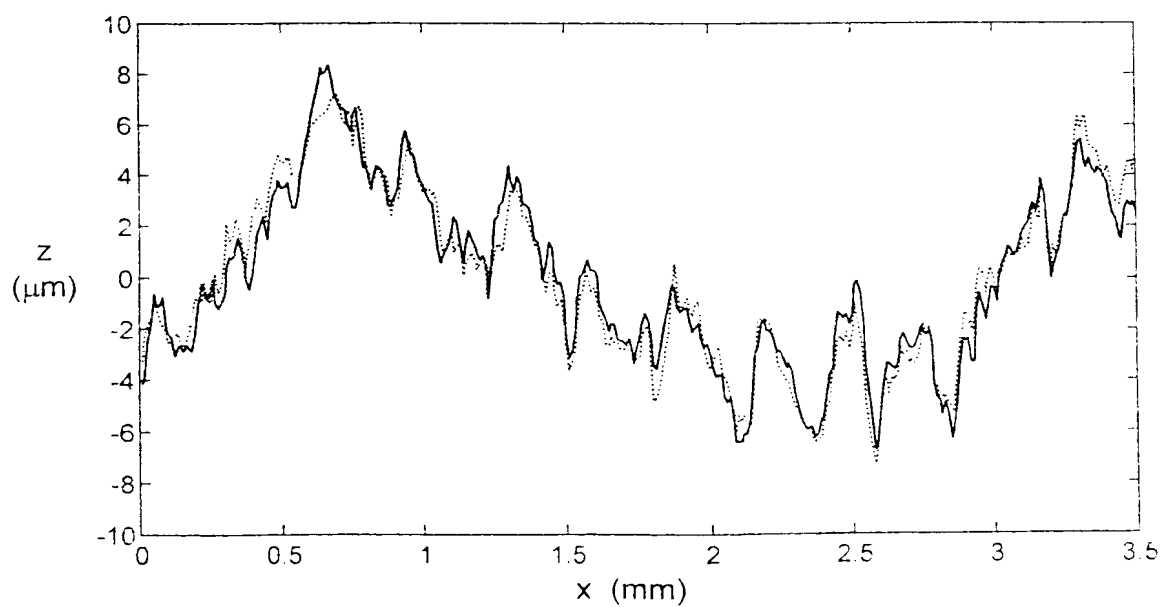


FIG.10

531 Rec'd FOL

25 JUL 2001